APPENDIX A

Habitat Mitigation and Natural Area Revegetation Plan

APPENDIX A TO THE BIOLOGICAL ASSESSMENT

Habitat Mitigation and Natural Area Revegetation Plan

Introduction

The proposed COB Energy Facility would be a combined-cycle electric generating plant fired solely on natural gas. The biological assessment (BA) contains a detailed description of the Energy Facility and its associated related and supporting facilities, collectively referred to as the Facility.

This Habitat Mitigation and Natural Area Revegetation Plan (the Revegetation Plan) describes revegetation and habitat improvement practices to be employed by COB Energy Facility, LLC (the project proponent) in areas that are in native condition, and not in agricultural use. It has been adapted from the revegetation plan (Exhibit P, Attachment P-1) in the site certificate application filed for the COB Energy Facility with the Oregon Office of Energy on September 5, 2002, as amended by Amendment No. 1, filed with the Oregon Energy Facility Council (EFSC) on July 25, 2003.

Conclusion

The project proponent would mitigate for permanently disturbed habitat by restoring, enhancing, and protecting habitat in accordance with Oregon Department of Fish and Wildlife (ODFW) habitat mitigation goals. Mitigation would include preservation, restoration, and habitat improvement of approximately 236 acres, including fallow agricultural land that has been heavily grazed, and degraded juniper sagebrush habitat on land that would be purchased by the project proponent (Figure 2-2 in the Biological Assessment). Detailed revegetation and habitat improvement plans for the mitigation site would be developed through consultations with the U.S. Fish and Wildlife Service (USFWS), ODFW, and the Bureau of Land Management (BLM).

Permanently disturbed habitats during the 30-year operating life of the proposed Facility are described in Table 2-1 of the BA. Only the Energy Facility site, water supply well system, and electric transmission line would have permanent disturbance. The water supply and natural gas pipelines would not have permanent disturbance, but would have temporary construction disturbances of 4 months and 3 months, respectively.

The revegetation goal for mitigation of permanently disturbed habitat is no net loss in either existing habitat quantity or quality. The Revegetation Plan has been prepared to guide the revegetation efforts and achieve this mitigation goal. The proposed Facility would permanently disturb approximately 108.7 acres during the 30-year operating life of the Energy Facility. At Facility retirement, the project proponent would implement a Facility Retirement and Site Restoration Plan (Exhibit W in the site certificate application) to ensure that soil in and around the Energy Facility site is returned to conditions suitable for agricultural use. The electric transmission line would be removed (i.e., the transmission towers, conductors and ground wires, and insulators) and the transmission tower footings would be removed to a depth of 5 feet. The natural gas and water supply pipelines would be capped and left in place. Proposed habitat mitigation and revegetation for temporary disturbances are summarized in Tables A-1 and A-2, respectively.

As shown in Table A-3, included in the mitigation is 94.9 acres of Klamath County mapped, high-density deer winter range (ODFW Category 2). A total of 46.0 acres would be permanently disturbed and 48.9 acres would be temporarily disturbed by the Facility. However, a large portion (approximately 57.9 acres) actually consists of fallow agricultural fields, which provide minimal habitat and forage value for wintering deer. This land does not provide biological value consistent with its Category 2 designation. If the approximately 51.9 acres were to be rated based on biological criteria, they would be Category 4. Nonetheless, the project proponent has evaluated these areas and would mitigate for them as Category 2.

The mitigation for Category 2 habitats would include restoration and improvement of areas permanently disturbed during the 30-year operating life of the Energy Facility by disturbance from the footprint area of the various Facility features. Mitigation for these areas would also involve a net improvement of existing habitat through removal of western juniper trees to promote growth of desirable forage species and the addition of watering stations for wildlife. The revegetation goal for temporarily disturbed areas is to return the disturbed habitat to preconstruction (or better) conditions.

Preliminary seed mixes, planting methods, and weed control techniques have been developed for the Facility site through a biological evaluation of the existing plant communities in the area and reviews of relevant literature. Final seed mixtures would be developed during consultation with the BLM, USFWS, and ODFW staff. The revegetation plan specifies monitoring procedures to evaluate the success of the revegetation efforts, and contingency measures if initial revegetation efforts prove unsuccessful in certain areas.

Environmental Setting

The Facility is located within the Klamath Ecological Province (East Cascades Ecoregion) on the eastern side of the Cascade Mountains. This region is characterized by large basins surrounded by ancient lake terraces and basaltic fault block mountains. Elevations range from about 4,000 to 8,000 feet. The soil in the area is derived from basaltic parent material and generally has loamy surface horizons overlaying loamy to clayey subsurface horizons. A silica cemented hardpan occurs at depths of about 3 feet in many of the ancient dry lakebeds in the area (Anderson et al., 1998; Franklin and Dyrness, 1988).

Historically, ponderosa pine forest accounted for nearly 50 percent of the vegetative cover in this region. However, since 1936, western juniper woodlands and agricultural areas have significantly expanded (Anderson et al., 1998). Sagebrush-steppe is also a major habitat type throughout this ecoregion (Franklin and Dyrness, 1988).

Proposed Habitat Preservation and Mitigation Site

Much of the area proposed for habitat mitigation and enhancement is located on a fallow agricultural field, as shown on Figure 2-2 in the BA. Until 1999, this land was used for dryland farming of cereal rye grass. Existing vegetation is sparse and includes species such as tansy mustard (*Descurainia sophia*), clasping pepperweed (*Lepidium perfoliatum*), blue-eyed Mary (*Collinsia parviflora*), and yellowspine thistle (*Cirsium ochrocentrum*).

The remaining mitigation and enhancement area is characterized by juniper woodland habitat consisting of a sparse understory with few shrubs and native grasses. Mapped habitat types are shown on Figure 4-1 in the BA.

Climate

The regional climate is characterized by warm, dry summers and cool, moist winters. The average annual precipitation in Klamath County is 14 inches, of which only 27 percent occurs during the growing season (Anderson et al., 1998).

Data from the Oregon Climate Service for Klamath Falls collected between 1971 and 2000 suggest that the average yearly precipitation is 13.95 inches, with average annual snowfall of 32.36 inches. Most of the precipitation occurs between November and March. The average maximum temperature for the year is 61.8 °F, and the average minimum temperature is 35.3 °F. The growing season extends from late April through October.

Current Land Use

The Energy Facility site is located on a fallow field that was used for dryland grain farming until 1999. The vegetation in this area is sparse and consists primarily of ruderal, non-native grasses and forbs. The fallow field and adjacent juniper-sagebrush habitats are currently leased for seasonal cattle grazing.

Water Supply Well System

The water supply well system is located on the east side of East Langell Valley Road at the existing Babson Well. The present-day land use is irrigated pasture, which is currently grazed by sheep.

Water Supply Pipeline

Land uses observed along the water supply pipeline route include irrigated pasture, an alfalfa hay field, open rangeland/woodlands managed by private landowners, and dryland farming and cattle grazing on a fallow field. The rangeland/woodlands are characterized by western juniper with an understory of low sagebrush, rabbitbrush, and annual grasses and forbs. Most of the juniper woodland area has been heavily grazed. Understory vegetation in these areas is sparse and consists primarily of non-native annual species.

Natural Gas Pipeline

Land uses observed along the natural gas pipeline route include irrigated pasture, a dairy, industrial land (the compressor station), farming practices related to cattle feed (alfalfa hay and grain silage), rangeland/woodlands where residents are located, and dryland farming and cattle grazing on a fallow field (the last section of the natural gas pipeline before it connects with the Energy Facility).

Electric Transmission Line

Land uses observed along the electric transmission line route include existing electric transmission lines, fallow agricultural fields used for cattle grazing, ponderosa pine woodland, open rangeland/woodlands managed by federal and private landowners, and the PG&E Gas Transmission Northwest (PG&E GTN) interstate gas pipeline system. The ponderosa pine woodland is isolated in a lowland area and is surrounded by rangeland areas characterized by western juniper.

Irrigated Pasture Area

The vegetation in this area is sparse and consists primarily of ruderal, non-native grasses and forbs. The fallow field and adjacent juniper-sagebrush habitats are currently leased for seasonal cattle grazing.

Soil

Several soil types are present on the Facility site, but most of the lands subject to revegetation are mapped as part of the Calimus or Lorella series. Other soil series found in the vicinity of the Facility include Harriman, Henly, Calimus fine sandy Loam, and the Stukel-Capona complex. .

The excavated topsoil (upper 12 inches) from the natural gas and water supply pipelines would be salvaged and stored prior to trench excavation. Once the pipelines have been installed, the topsoil would be replaced over the refilled trench and the surface would be regraded to original contours. Prior to seeding, the soil may be disked to ensure good seedling establishment.

Existing Vegetation

General habitat and vegetation descriptions are provide in the BA. Juniper-sagebrush is the predominant natural habitat in the Facility vicinity. Other impacted natural habitat types include sagebrush-steppe and ponderosa pine woodland.

Noxious Weeds

A noxious weed is a plant that is considered aggressive and intrusive, resulting in detrimental impacts to important native species, habitats, and agriculture. Such plants are difficult to control or eradicate. The Oregon Department of Agriculture designates plant species as noxious weeds and classifies species on the size of the infestation, ability to control and eradicate, and economic as well as ecological significance.

The project proponent would use Best Management Practices (BMPs) to avoid and minimize potential impacts from noxious weeds. During construction, efforts would be made to minimize the spread of noxious weeds and other undesirable non-native species. Removal of exotic invasive plants would be performed on an as-needed basis during the revegetation process. Weed control treatment methods may include hand pulling of small, isolated, herbaceous populations; limited spot application of herbicide (e.g., Roundup); mechanically disking to a 6-inch depth; or cutting (e.g., weed-eaters, mowing).

The goal of weed control efforts would be to remove competitive, non-native vegetation and prevent the spread and establishment of noxious weeds and other undesirable plant species into new areas as a result of Facility construction. In areas where weedy species are present, the goal is to prevent increased weed density, control and maintain the spread, and reduce the population where possible. Complete eradication of undesirable species is not likely. However, weed populations should not exceed the baseline conditions in any of the revegetated areas. Establishment of native vegetation would prevent establishment of noxious weeds in the mitigation and enhancement areas.

The following noxious weeds have been observed in the Facility area and have the potential to spread as a result of increased disturbance, inhibit natural regeneration of desirable species, and reduce the success of revegetation efforts:

- Leafy spurge (*Euphorbia esula*)—Widespread, but not abundant in the project area.
- Bull thistle (*Cirsium vulgare*)—Widespread, but not abundant in the project area.
- Field bindweed (*Convolvulus arvensis*)—Common in fallow agricultural fields, but limited distribution in the project area
- Medusa-head (*Taeniatherum caput-medusae*)—Limited to the area around Captain Jack Substation; species is present, but not abundant
- Quack grass (*Elytrigia repens*)—Limited distribution in the project area in pastures and along roadsides
- Scotch thistle (*Onopordum acanthium*)—Locally common in disturbed areas, limited where dense native vegetation is present
- Musk thistle (*Carduus nutans*)—Locally common in disturbed areas, limited where dense native vegetation is present

Other non-native, weedy species common in the area included:

- Yellow spine thistle (*Cirsium ochrocentrum*)—Common in fallow agricultural fields
- Cheatgrass (*Bromus tectorum*)—Locally common in highly disturbed areas, but limited where dense native vegetation is present
- Tansy mustard (*Descurainia sophia*)—Common in fallow agricultural fields and highly disturbed areas
- Field pepperweed (*Lepidium campestre*)—Common in fallow agricultural fields
- Tumble mustard (*Sisymbrium altissimum*)—Common in fallow agricultural fields
- Tubercled crowfoot (*Ranunculus testiculatus*)—Common in some highly disturbed areas
- Common mullein (*Verbascum thapsus*)—Locally abundant in areas along the PGT natural gas easement

Erosion Control

The project proponent would implement and follow an erosion and sediment control plan as part of the 1200-C construction National Pollutant Discharge Elimination System (NPDES) permit. For temporary disturbance, control measures would be used to redirect surface runoff, decrease the velocity of surface runoff, capture suspended sediment, and stabilize exposed soil. These measures include, but are not limited to, the use of straw bales, sandbags, and silt fences. These erosion control measures would be used along the perimeters of the work areas and wherever else appropriate to prevent sediment runoff and debris from entering drainages or other sensitive habitat. Following construction, areas of disturbance would be seeded with native vegetation to provide long-term erosion control.

Restoration of Temporarily Disturbed Sites and Habitat Mitigation

Temporary Disturbance

The goal for revegetation of temporarily disturbed areas is to return the site to the predisturbance condition or better (with the exception of ponderosa pine trees within the electric transmission line easement). The existing vegetation in adjacent, undisturbed areas would provide reference conditions for revegetation of the disturbed areas. If the adjacent areas are generally denuded or characterized by undesirable species, the revegetation goal is to enhance the habitat by planting desirable native species. Where temporary disturbance occurs in areas that are considered relatively undisturbed, the mitigation goal is to return the habitat to predisturbance conditions.

Habitat Preservation, Mitigation and Enhancement

The goal for mitigation and enhancement areas for the Facility’s permanent disturbance during the 30-year operating life of the Energy Facility is to transform relatively poor quality habitat such as fallow agricultural land and barren juniper woodland into productive, high-quality wildlife habitat by planting desirable species for deer, antelope, pygmy rabbits, and other wildlife species. Improvement of Category 2 habitat areas would involve the removal of dense juniper to improve the growth and establishment of desirable species, and the addition of wildlife watering stations.

Revegetation and Habitat Improvement Procedures

Select Qualified Revegetation Contractor

The revegetation contractor would have a demonstrated record of successfully implementing revegetation projects of comparable size and type.

Determine Seed Mixture and Application Rates

A list of potential plant species to be used in temporarily and permanently disturbed natural habitats as well as in the habitat mitigation and enhancement area is provided in Table A-4. Species were selected based on existing vegetation, current land use, and habitat enhancement and mitigation goals in each disturbance location. The final seed mixture, planting rates, and seed source would be subject to approval by ODFW, USFWS, and the BLM prior to revegetation planting. Revegetation planting and management for temporary disturbance on private lands in native condition (including native areas in degraded condition), for which the project proponent has obtained a construction easement, would be subject to the approval of the landowner. These areas may include some non-native species (e.g., annual grasses) which are better suited for the current land use activities.

Planting Methods

Planting methods would be based on site-specific factors, such as slope, soil, and the size of the planting area. Certified weed-free seed would be used for all areas.

Rangeland Seed Drill Method

A seed drill would be used for revegetation of pastureland and natural areas along the natural gas and water supply pipelines, and for the mitigation and habitat enhancement of areas such as fallow agricultural fields.

Broadcast Seeding

Broadcast seeding would be used to replant small areas or sites where drill seeding is not possible, such as steep slopes and extremely stony or rocky soil. In these areas, seed would be spread using a belly grinder or some other form of dispersal mechanism.

Container Planting

Curl-leaf mountain mahogany (*Cercocarpus ledifolius*) and antelope bitterbrush (*Purshia tridentata*) have poor germination and survival when planted as seed. Therefore, establishment of these species would be accomplished by planting container grown plants. Mulch would be placed around the base and each plant would be protected with mesh to prevent browsing during initial seedling establishment.

Juniper Removal

Removal of western juniper trees would promote growth of desirable browse species as well as herbaceous vegetation. Juniper thinning would be done in areas of the 235.5-acre habitat preservation site as well as on the 62.3 acres of temporarily and permanently disturbed ODFW Category 2 habitat (see Figure 2-2 in the BA). Removal of juniper tree would most likely be done using a mechanical harvester with rubber tires.

Success Criteria

Revegetation success criteria would be determined through (1) comparison of the restored and enhanced habitats with vegetation on adjacent, undisturbed areas, (2) selected reference sites nearby the Facility, or (3) other success criteria established by ODFW, BLM, and/or USFWS. Restoration success would be based on the results as determined by the monitoring procedures discussed below.

Monitoring Procedures

During the year following each seeding, a qualified botanist or restoration expert would examine a representative sample of the revegetated sites. Care would be taken to survey areas in all the major habitat types and throughout the geographic extent of the revegetation area. At least 10 percent of the revegetated acreage would be examined.

Reference sites are areas of natural vegetation that have not been subject to disturbance as a result of the project. Restored and mitigation areas should be similar in composition and structure to undisturbed natural vegetation in the area or meet otherwise predetermined standards. Reference sites nearby the Facility would be selected on the basis of target plant community composition and environmental parameters (soil, slope, aspect, grazing pressure) similar to the revegetated areas. A minimum of three reference sites would be used to establish success criteria. Within each selected reference area, a minimum of three 16.5 feet by 16.5 feet sample plots would be randomly located. Data collected from each plot would include:

- Species composition
- Plant density
- Percent cover of vegetation (both native and non-native herbaceous and woody species), as well as bare soil and rock
- Community structure
- Degree of erosion due to construction activities (high, moderate, or low)
- Representative photos from each sampling location

The same sampling protocol would be used to assess the revegetation success of the disturbed natural habitats and the mitigation and enhancement planting areas. The objective of revegetation and mitigation planting is no net loss in habitat quantity or quality. Success of the revegetation areas would be determined relative to the conditions of the selected reference sites. Parameter measures in the revegetated areas should be within 15 percent of the reference locations. Access to revegetation sites would be provided to pertinent regulatory agencies with 48 hours advance notice.

Fencing

The habitat mitigation and improvement sites would be fenced prior to seeding. Fences would be designed to exclude cattle and other domestic ungulates, but would allow access to mule deer and antelope in accordance with ODFW guidelines. Domestic grazing would not occur in the habitat mitigation and enhancement areas unless it is determined that limited grazing would be a beneficial management practice. The fences would be maintained throughout the life of the Facility.

Maintenance

The COB Energy Facility would be responsible for the continued maintenance activities associated with the habitat mitigation and preservation areas. Maintenance activities could include fence repair, periodic weed control, juniper removal, monitoring of improvement success, and reseeding (in areas where vegetation establishment fails to meet the success criteria).

Remedial Actions

During the initial stages of monitoring, the germination and establishment success of target species would be closely tracked. In the event that the initial planting appears insufficient to achieve revegetation goals, additional seeding, mulching, or plug planting may be required.

Reporting Schedule

Within 60 days of completion of seeding and planting the revegetation project, an as-built report would be prepared. The as-built report would identify any changes from the original plan, such as changes in composition of the seed mix and application methods. The as-built report would serve as a baseline for future monitoring reports.

In addition, an annual monitoring report would be submitted by October 1 of each year that monitoring is conducted. The monitoring report would outline results of vegetation sampling and photo monitoring, and identify any remedial action recommended to meet goals.

References

Anderson, W.E., M. Borman, and W.C. Kruger. 1998. *The Ecological Provinces of Oregon*. Oregon Agricultural Experiment Station, SR990.

Franklin, J.F and C.T. Dyrness. 1988. *Natural Vegetation of Oregon and Washington*. Oregon State University Press, Corvallis, Oregon.

Natural Resource Conservation Service (NRCS). 1985. Soil Survey of Klamath County, Oregon: Southern Part. United States Department of Agriculture.

TABLE A-1
Proposed Mitigation for Permanent and Temporary Disturbance of Natural Habitat Areas

Summary of Disturbance	Proposed Mitigation Measures
54.4 acres of permanent disturbance during the 30-year operating life of the Energy Facility to natural habitats including juniper-sagebrush (31.6 acres), sagebrush- steppe (10.4 acres), and ponderosa pine woodland (12.4 acres).	Creation and preservation of an approximately 236-acre habitat mitigation site. Creation of a minimum of 2 snag trees per acre within the ponderosa pine woodland area.
46.0 acres of permanent disturbance during the 30-year operating life of the Energy Facility to high-density winter deer range habitat (ODFW habitat category 2). 48.9 acres of temporary disturbance to high-density winter deer range habitat (ODFW habitat category 2).	Creation and preservation of an approximately 236-acre habitat mitigation site. Implementation of net habitat improvement by thinning western juniper trees within the 154-foot easement for the electric transmission line on 79.7 acres of juniper-sage habitat. The purpose would be to promote growth of desirable browse species. Installation of wildlife watering stations on the mitigation site and along the electric transmission line.
Additional temporary disturbance to 26.2 acres of natural habitats including juniper-sagebrush (22.8 acres), sagebrush-steppe (1.8 acres), and ponderosa pine woodland (12.4 acres).	Revegetation of temporary disturbed sagebrush habitat areas to predisturbance conditions or better. Revegetation of temporary disturbed habitats within the right-of-way in the ponderosa pine habitat. Would include a variety of low-growing shrubs, native grasses, and forbs to promote habitat diversity, forage availability and wildlife habitat.

TABLE A-2
Revegetation and Restoration of Temporarily Disturbed Areas

Facility Feature	Habitat and Soil	Impacts	Revegetation and Habitat Enhancement[1]
Electric transmission line	Juniper-Sagebrush (35.2 acres) Lorella and Calimus gravelly, stony loams, with 2 to 35% slopes	Tree removal, tower construction, and conductor installation	Broadcast seeding of native grasses, forbs, and shrubs (mostly low sagebrush, with some serviceberry and gooseberry)
	Sagebrush-steppe (12.2 acres) Calimus fine sandy loam and Harriman loams, with 2 to 15% slopes	Tower construction and conductor installation	Broadcast seeding of native grasses, forbs, and big sagebrush. Plug planting of bitterbrush.
	Ponderosa Pine (14.0 acres) Harriman loam with 2 to 15% slopes	Tree removal, tower construction, and conductor installation	Juniper clearing, creation of snags. Broadcast seeding of native grasses, forbs, and shrubs (service berry, gooseberry), plug planting of curl-leaf mountain mahogany
	Pasture (2.4 acres) Harriman loam with 0 to 15% slopes	Tower construction and conductor installation	Minimization and mitigation practices in accordance with Attachment K-5 of the COB Energy Facility site certificate application
	Fallow Field (1.1 acres) Harriman loam with 0 to 15% slopes	Tower construction and conductor installation	Drill seeding of native grasses and forbs
Natural gas pipeline easement corridor (not including 3.6 acres of temporary disturbance on PG&E Gas Transmission Northwest property, which is industrially developed land)	Juniper-sagebrush (9.0 acres) Lorella and Calimus loam and gravelly, stony loam with 2 to 35% slopes	Clearing, trench excavation, and soil stockpiling	Drill seeding of native grasses, forbs, and shrubs (low sagebrush, gooseberry, and serviceberry). Plug planting of bitterbrush and curl-leaf mountain mahogany.
	Agricultural fields (23.9 acres) Calimus and Henly loams with 0 to 5% slopes and Stukel-Capona loams with 2-15% slopes.	Clearing, trench excavation, and soil stockpiling	Minimization and mitigation practices in accordance with Attachment K-5 of the COB Energy Facility site certificate application
	Pasture (0.8 acre) Calimus loam with 0 to 5% slopes and Stukel-Capona loams with 2 to 15 percent slopes	Clearing, trench excavation, and soil stockpiling	Minimization and mitigation practices in accordance with Attachment K-5 of the COB Energy Facility site certificate application

TABLE A-2
Revegetation and Restoration of Temporarily Disturbed Areas

Facility Feature	Habitat and Soil	Impacts	Revegetation and Habitat Enhancement[1]
	Fallow Field (3.5 acres) Calimus loam with 2 to 5% slopes	Clearing, trench excavation, and soil stockpiling	Drill seeding of native grasses, forbs
	Ruderal—private property (3 acres) Calimus loam with 0 to 5% slopes	Clearing, trench excavation, and soil stockpiling	Per landowner specifications
Water pipeline construction corridor	Juniper-Sagebrush (10.2 acres) Lorella and Calimus loam and gravelly, stony loam, with 2 to 35% slopes	Clearing, trench excavation, and soil stockpiling	Drill seeding of native grasses, forbs and shrubs (low sagebrush, gooseberry and serviceberry). Plug planting of bitterbrush and curl-leaf mountain mahogany.
	Agricultural fields (1.4 acres) Stukel-Capona loam, with 2-15% slopes	Clearing, trench excavation, and soil stockpiling	Minimization and mitigation practices in accordance with Attachment K-5.
	Pasture (6.3 acres) Calimus loams with 0-5% slopes, Laki and Henly loams with 0-2% slopes	Clearing, trench excavation, and soil stockpiling	Minimization and mitigation practices in accordance with Attachment K-5 of the COB Energy Facility site certificate application
	Fallow fields (0.8 acres) Calimus loam, 2-5% slope	Clearing, trench excavation, and soil stockpiling	Drill seeding of native grasses, forbs and shrubs (low sagebrush, gooseberry and serviceberry). Plug planting of bitterbrush and curl-leaf mountain mahogany.
	Ruderal (0.7 acre) Calimus fine sandy loam and Laki-Henly loams with 0-5% slopes	Clearing, trench excavation, and soil stockpiling	Minimization and mitigation practices in accordance with Attachment K-5 of the COB Energy Facility site certificate application.
Water supply staging area	Pasture (1.3 acres) Calimus loam, 0-5% slopes	Clearing and leveling	Minimization and mitigation practices in accordance with Attachment K-5 of the COB Energy Facility Site Certificate Application.
Irrigation pipeline	Fallow field (5.2 acres)	Clearing, trench excavation, and soil stockpiling	Drill seeding of native grasses and forbs

TABLE A-3
Permanent and Temporary Disturbances of ODFW Habitats (in acres)

Feature	Total	ODFW 2	ODFW 3	ODFW 4	ODFW 5	ODFW 6
Permanent						
Energy Facility site	50.6	13.9	4.2	32.5		
Water supply well system	0.3			0.3		
Water supply pipeline	0.0					
Natural gas pipeline	0.0					
Electric transmission line	57.3	31.6	25.7			
Access Road to Pasture	0.5	0.5				
Total—Permanent	**108.7**	**46.0**	**29.9**	**32.8**	**0.0**	**0.0**
Additional Temporary Disturbance						
Construction parking/laydown	71.0	19.7	6.4	44.9		
Water supply well system	1.0			1.0		
Water supply pipeline	19.4	6.6	1.8	11.0		
Natural gas pipeline	43.8	13.1		27.1		3.6
Electric transmission line	7.6	4.7	2.9			
Irrigation Pipeline	5.2	4.8		0.4		
Total—Additional Temporary Disturbance	**148.0**	**48.9**	**11.1**	**84.4**	**0.0**	**3.6**
Total—Permanent and Temporary	**256.7**	**94.9**	**41.0**	**117.2**	**0.0**	**3.6**

TABLE A-4
Proposed Native Plant Species for Revegetation

Native Grasses	
Thurber's needlegrass	*Achnatherum thurberianum*
Squirrel Tail	*Elymus elymoides*
Idaho Fescue	*Festuca idahoensis*
Sandberg's Bluegrass	*Poa secunda*
Bluebunch wheatgrass	*Pseudoroegneria spicata*
Native Forbs	
Sagebrush buttercup	*Ranunculus glaberrinus*
Common Lomatium	*Lomatium utriculatum*
Wooly sunflower	*Eryophylum lanatum*
Prairie lupine	*Lupinus lepidus*
Velvet Lupine	*Lupinus leucophyllus*
Spreading Phlox	*Phlox diffusa*
Showy Penstemon	*Penstemon speciosus*
Shrubs	
Low sagebrush	*Artemisia arbuscula*
Big Sagebrush	*Artemisia tridentata*
Antelope bitterbrush	*Purshia tridentata*
Curl-leaf mountain mahogany	*Cercocarpus ledifolius*
Desert gooseberry	*Ribes velutinum*
Serviceberry	*Amelanchier alnifolia*

APPENDIX B

Plant and Wildlife Species Observed During Field Surveys in the Project Area

APPENDIX B TO THE BIOLOGICAL ASSESSMENT

Plant and Wildlife Species Observed During Field Surveys in the Project Area

TABLE B-1
Plant Species Observed During Botanical Surveys of the Project Area

Scientific Name	Common Name	Native/ Non-native	Habitat
Apiaceae			
Lomatium nudicaule	Pestle lomatium	Native	Perennial
Lomatium triternatum	Lewis' lomatium	Native	Perennial
Lomatium utriculatum	Common lomatium	Native	Perennial
Perideridia oregana	Oregon yampah	Native	Perennial
Asclepiadaceae			
Asclepias speciosa	Showy milkweed	Native	Perennial
Asteraceae			
Achillea millefolium	Yarrow	Native	Perennial
Agoseris glauca	Pale agoseris	Native	Perennial
Antennaria rosea	Rosy pussytoes	Native	Perennial
Anthemis arvensis	Corn chamomile	Non-native	Annual
Artemisia arbuscula	Low sagebrush	Native	Shrub
Artemisia tridentata	Big sagebrush	Native	Shrub
Balsamorhiza sagittata	Arrow-leaved balsam-root	Native	Perennial
Bidens cernua var. *cernua*	Nodding bur-marigold	Native	Perennial
Blepharipappus scaber	Blepharipappus	Native	Annual
*Carduus nutans**	Musk thistle	Non-native	Perennial
Chrysothamnus nauseosus	Grey rabbitbrush	Native	Shrub
Chrysothamnus viscidiflorus	Green rabbitbrush	Native	Shrub
*Cirsium ochrocentrum**	Yellow-spine thistle	Non-native	Perennial
*Cirsium vulgare**	Bull thistle	Non-native	Bien.
Crepis acuminata	Tapertip hawksbeard	Native	Perennial
Crepis modocensis	Low hawksbeard	Native	Perennial
Crocidium multicaule	Spring gold	Native	Annual
Erigeron bloomeri	Scabland fleabane	Native	Perennial
Erigeron filifolius var. *filifolius*	Thread-leaved fleabane	Native	Perennial
Eriophyllum lanatum	Wooly sunflower	Native	Perennial
Microseris laciniata	cutleaf silverpuffs	Native	Perennial
Microseris nutans	Nodding microseris	Native	Perennial
Onopordum acanthium ssp. *acanthium**	Scotch thistle	Non-native	Bien.
Psilocarphus brevissimus	Dwarf wooly-heads	Native	Annual
Senecio canus	Grey groundsel	Native	Perennial

TABLE B-1
Plant Species Observed During Botanical Surveys of the Project Area

Scientific Name	Common Name	Native/ Non-native	Habitat
Senecio integerrimus var. *exaltatus*	Western groundsel	Native	Perennial
Senecio integerrimus var. *major*	Lambstongue groundsel	Native	Perennial
Stenotus stenophyllus	Narrow -leaf goldenweed	Native	Annual
Taraxacum officinale	Dandelion	Non-native	Perennial
Tragopogon dubius	Goat's beard	Non-native	Perennial
Wyethia angustifolia	Narrow-leaf mule ears	Native	Perennial
Boraginaceae			
Amsinckia sp.	Fiddleneck	---	---
Cryptantha ambigua	Basin cryptantha	Native	Annual
Cryptantha sp.	Cryptantha	---	---
Hackelia cusickii	Cusicks stickseed	Native	Perennial
Lithospermum ruderale	Stoneseed	Native	Perennial
Plagiobothrys stipitatus	Popcorn flower	Native	Annual
Brassicaceae			
Alyssum alyssoides	Small alyssum	Non-native	Annual
Arabis X*divaricarpa*	Rockcress	Non-native	Perennial
Descurainia sophia	Tansy mustard	Non-native	Annual
Idahoa scapigera	Flat-pod	Native	Annual
Lepidium campestre	Field pepperweed	Non-native	Annual
Lepidium perfoliatum	Clasping pepperweed	Non-native	Annual
Phoenicaulis cheiranthoides	Daggerpod	Native	Perennial
Sisymbrium altissimum	Tumble mustard	Non-native	Annual
Campanulaceae			
Downingia sp.	Downingia	---	---
Caprifoliaceae			
Sambucus mexicana	Blue elderberry	Native	Shrub
Caryophyllaceae			
Arenaria aculeata	Needleleaf sandwort	Native	Perennial
Arenaria congesta var. *congesta*	Ballhead sandwort	Native	Perennial
Silene sp.	Campion	---	---
Chenopodiaceae			
Chenopodium album	Lambs quarters	Non-native	Annual
Salsola tragus	Russian thistle	Non-native	Annual
Convolvulaceae			
*Convolvulus arvensis**	Field bindweed	Non-native	Annual
Cupressaceae			
Juniperus occidentalis	Western juniper	Native	Tree
Cyperaceae			
Carex filifolia	Thread-leaf sedge	Native	Perennial
Carex sp.	Sedge	---	---

TABLE B-1
Plant Species Observed During Botanical Surveys of the Project Area

Scientific Name	Common Name	Native/ Non-native	Habitat
Eleocharis macrostachya	Creeping spikerush	Native	Perennial
Scirpus acutus	Tule	Native	Perennial
Dryopteridaceae			
Cystopteris fragilis	Fragile fern	Native	Fern
Euphorbiaceae			
*Euphorbia esula**	Leafy spurge	Non-native	Perennial
Fabaceae			
Astragalus curvicarpus var. *curvicarpus*	Curvepod milkvetch	Native	Perennial
Astragalus filipes	Basalt milkvetch	Native	Perennial
Astragalus purshii	Pursh's milkvetch	Native	Perennial
Lupinus lepidus var. *sellulus*	Prairie lupine	Native	Perennial
Lupinus leucophyllus	Velvet lupine	Native	Perennial
Medicago sativa	Alfalfa	Non-native	Perennial
Melilotus indica	Sour clover	Non-native	Annual
Vicia americana	American vetch	Non-native	Annual
Gentianaceae			
Swertia albicaulis	Whitestem gentian	Native	Perennial
Geraniaceae			
Erodium cicutarium	Storksbill	Non-native	Annual
Grossulariaceae			
Ribes velutinum	Desert gooseberry	Native	Shrub
Hydrophyllaceae			
Hydrophyllum capitatum	Alpine waterleaf	Native	Perennial
Nemophila pedunculata	Meadow nemophila	Native	Annual
Phacelia hastata	Silverleaf phacelia	Native	Perennial
Phacelia heterophylla ssp. *virgata*	Varileaf phacelia	Native	Perennial
Phacelia linearis	Threadleaf phacelia	Native	Annual
Juncaceae			
Juncus balticus	Baltic rush	Native	Perennial
Lamiaceae			
Agastache urticifolia	Nettle-leaved horsemint	Native	Perennial
Marrubium vulgare	Horehound	Non-native	Perennial
Lemnaceae			
Lemna minor	Duckweed	Native	Perennial
Liliaceae			
Calochortus macrocarpus	Sagebrush mariposa lily	Native	Perennial
Fritillaria atropurpurea	Spotted fritillary	Native	Perennial
Smilacina racemosa	Western Solomon's seal	Native	Perennial
Zigadenus venenosus var. *venenosus*	Death camas	Native	Perennial

TABLE B-1
Plant Species Observed During Botanical Surveys of the Project Area

Scientific Name	Common Name	Native/ Non-native	Habitat
Linaceae			
Hesperolinon micranthum	Threadstem flax	Native	Annual
Linum lewisii	Western blue flax	Native	Perennial
Loasaceae			
Mentzelia veatchiana	Veatchs blazingstar	Native	Annual
Malvaceae			
Malva neglecta	Common mallow	Non-native	Perennial
Sidalcea oregana	Oregon checker mallow	Native	Perennial
Onagraceae			
Camissonia tanacetifolia	Tansy-leaved evening primrose	Native	Perennial
Clarkia rhomboidea	Forest clarkia	Native	Annual
Pinaceae			
Pinus ponderosa	Ponderosa pine	Native	Tree
Poaceae			
Achnatherum thurberianum	Thurber’s needlegrass	Native	Perennial
Alopecurus pratensis	Meadow foxtail	Non-native	Perennial
Agropyron desertorum	Desert crested wheatgrass	Non-native	Perennial
Agrostis exarata	Spike bentgrass	Native	Perennial
Beckmannia syzigachne	Slough grass	Native	Annual
Bromus madritensis ssp. *rubens*	Red brome	Non-native	Annual
Bromus tectorum	Cheat grass	Non-native	Annual
Deschampsia danthonioides	Annual hairgrass	Native	Annual
Elymus elymoides	Squirreltail	Native	Perennial
Elytrigia elongata	Tall wheatgrass	Non-native	Perennial
Elytrigia intermedia	Intermediate wheatgrass	Non-native	Perennial
*Elytrigia repens**	Quack grass	Non-native	Perennial
Festuca arundinacea	Tall fescue	Non-native	Perennial
Festuca idahoensis	Idaho fescue	Native	Perennial
Hordeum murinum spp. *leporinum*	Farmers foxtail	Non-native	Annual
Leymus triticoides	Creeping wildrye	Native	Perennial
Poa pratensis	Kentucky bluegrass	Non-native	Perennial
Poa secunda	Bluegrass	Native	Perennial
Polypogon monspeliensis	Annual beardgrass	Non-native	Annual
Pseudoroegneria spicata	Bluebunch wheatgrass	Native	Perennial
Secale cereale	Cereal rye	Non-native	Annual
*Taeniatherum caput-medusae**	Medusa head	Non-native	Annual
Polemoniaceae			
Collomia grandiflora	Mountain collomia	Native	Annual
Ipomopsis aggregata	Scarlet gilia	Native	Perennial

TABLE B-1
Plant Species Observed During Botanical Surveys of the Project Area

Scientific Name	Common Name	Native/ Non-native	Habitat
Navarretia leucocephala	White-headed navarretia	Native	Annual
Phlox diffusa	Spreading phlox	Native	Perennial
Polygonaceae			
Eriogonum sphaerocephalum var. *halimioides*	Rock buckwheat	Native	Perennial
Eriogonum umbellatum	Sulfur-flower buckwheat	Native	Perennial
Rumex crispus	Curly dock	Non-native	Perennial
Portulacacaea			
Claytonia perfoliata	Miner's lettuce	Native	Annual
Potomagetonaceae			
Potamogeton sp.	Pondweed	---	---
Primulaceae			
Dodecatheon conjugens	Shooting star	Native	Perennial
Dodecatheon pulchellum	Dark-throat shooting star		Perennial
Ranunculaceae			
Adonis aestivalis	Summer pheasant's eye	Non-native	Annual
Delphinium nuttallianum	Dwarf larkspur	Native	Perennial
Myosurus minimus	Mouse-tail	Native	Annual
Ranunculus aquatilus	Aquatic buttercup	Native	Perennial
Ranunculus glaberrimus	Sagebrush buttercup	Native	Perennial
Ranunculus testiculatus	Tubercled crowfoot	Non-native	Annual
Rosaceae			
Amelanchier alnifolia	Service-berry	Native	Shrub
Cercocarpus ledifolius	Mountain mahogany	Native	Perennial
Geum triflorum	Old man's beard	Native	Perennial
Prunus subcordata	Klamath Plum	Native	Perennial
Purshia tridentata	Antelope bitterbrush	Native	Shrub
Rosa woodsii	Interior rose	Native	Shrub
Rubiaceae			
Galium aparine	Common bedstraw	Native	Annual
Galium sp.	Bedstraw	---	---
Salicaceae			
Populus tremuloides	Quaking aspen	Native	Tree
Saxifragaceae			
Lithophragma parviflorum	Woodland star	Native	Perennial
Scrophulariaceae			
Castilleja linariifolia	Desert paintbrush	Native	Perennial
Collinsia parviflora	Blue-eyed Mary	Native	Annual
Penstemon laetus	Mountain blue penstemon	Native	Perennial
Penstemon rydbergii var. *oreocharis*	Meadow beardtongue	Native	Perennial
Penstemon speciosus	Showy penstemon	Native	Perennial

TABLE B-1
Plant Species Observed During Botanical Surveys of the Project Area

Scientific Name	Common Name	Native/ Non-native	Habitat
Verbascum thapsus	Common mullein	Non-native	Perennial
Veronica anagallis-aquatica	Water speedwell	Non-native	Perennial
Veronica peregrina var. *xalapensis*	Purslane speedwell	Native	Annual
Solonaceae			
Nicotiana attenuata	Coyote tobacco	Native	Annual
Typhaceae			
Typha latifolia	Broad-leaved cattail	Native	Perennial
Valerianaceae			
Plectritis brachystemon	Short-spurred plectritis	Native	Annual
Violaceae			
Viola bakeri	Baker’s violet	Native	Perennial

Note:

* Indicates that the species is an Oregon Department of Agriculture List B noxious weed.

Taxonomy follows the protocol in *The Jepson Manual—Higher Plants of California.* 1993. J.C. Hickman, ed. University of California Press, Berkeley.

TABLE B-2
Wildlife Species Observed During Field Surveys of the Project Area

Common Name	Scientific Name	Observed Habitat*
Birds		
Pied-billed grebe	*Podilymbus podiceps*	WO
American white pelican	*Pelecanus erythrorhynchos*	T, P
Great blue heron	*Ardea herodias*	WO
Sandhill crane	*Grus canadensis*	WO
Green-winged teal	*Anas crecca*	WO
Mallard	*Anas platyrhynchos*	WO, T
Northern shoveler	*Anas clypeata*	WO
American wigeon	*Anas americana*	WO
Bufflehead	*Bucephala albeola*	WO
Common merganser	*Mergus merganser*	WO
Turkey vulture	*Cathartes aura*	P, GP, WO, T
Bald eagle	*Haliaeetus leucocephalus*	WO, P, T, GP
Northern harrier	*Circus cyaneus*	WO, GP, P
Sharp-shinned hawk	*Accipiter striatus*	T
Cooper’s hawk	*Accipiter cooperii*	T
Red-tailed hawk	*Buteo jamaicensis*	T, WO, GP, P
Swainson’s hawk	*Buteo swainsoni*	WO, T, GP, P
Rough-legged hawk	*Buteo lagopus*	WO, GP, P
California quail	*Callipepla californica*	WO, P
American coot	*Fulica americana*	WO
Killdeer	*Charadrius vociferus*	T, WO, GP, P
Wouldet	*Catoptrophorus semipalmatus*	WO
Common snipe	*Gallinago gallinago*	WO
Gull	*Larus* sp.	WO, P, GP
Forster’s tern	*Sterna forsteri*	WO
Rock dove	*Columba livia*	WO, GP
Mourning dove	*Zenaida macroura*	T, GP
Great horned owl	*Bubo virginianus*	T
Common nighthawk	*Chordeiles minor*	T
Anna’s hummingbird	*Calypte anna*	T, WO
Calliope hummingbird	*Stellula calliope*	T
Red-breasted sapsucker	*Sphyrapicus ruber*	T
Downy woodpecker	*Picoides pubescens*	T

TABLE B-2
Wildlife Species Observed During Field Surveys of the Project Area

Common Name	Scientific Name	Observed Habitat*
Northern flicker	*Colaptes auratus*	T, WO, GP, P
Say's phoebe	*Sayornis saya*	T
Ash-throated flycatcher	*Myiarchus cinerascens*	T, WO
Western kingbird	*Tyrannus verticalis*	WO, GP, P, T
Cliff swallow	*Hirundo pyrrhonota*	WO, GP
Steller's jay	*Cyanocitta stelleri*	WO, T, P
Western scrub jay	*Aphelocoma coerulescens*	P, T, WO
Black-billed magpie	*Pica pica*	T, WO, GP, P
American crow	*Corvus brachyrhynchos*	GP
Common raven	*Corvus corax*	WO
Black-capped chickadee	*Parus atricapillus*	T
Mountain chickadee	*Parus gambeli*	P
White-breasted nuthatch	*Sitta carolinensis*	T
Rock wren	*Salpinctes obsoletus*	T
Ruby-crowned kinglet	*Regulus calendula*	T
Western bluebird	*Sialia mexicana*	WO, P
Mountain bluebird	*Sialia currucoides*	T
American robin	*Turdus migratorius*	WO, T
Northern mockingbird	*Mimus polyglottos*	WO, P
Loggerhead shrike	*Lanius ludovicianus*	GP
European starling	*Sturnus vulgaris*	WO, P
Warbling vireo	*Vireo gilvus*	WO, P
Yellow-rumped warbler	*Dendroica coronata*	WO
Western tanager	*Piranga ludoviciana*	WO, T
Spotted towhee	*Pipilo maculatus*	T
Lark sparrow	*Chondestes grammacus*	T, WO, P
Song sparrow	*Melospiza melodia*	WO
Golden-crowned sparrow	*Zonotrichia atricapilla*	T, WO, P
White-crowned sparrow	*Zonotrichia leucophrys*	WO
Dark-eyed junco	*Junco hyemalis*	P
Red-winged blackbird	*Agelaius phoeniceus*	WO
Tricolored blackbird	*Agelaius tricolor*	WO
Western meadowlark	*Sturnella neglecta*	WO, T, GP
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*	WO

TABLE B-2
Wildlife Species Observed During Field Surveys of the Project Area

Common Name	Scientific Name	Observed Habitat*
Brewer's blackbird	*Euphagus cyanocephalus*	WO
Brown-headed cowbird	*Molothrus ater*	WO
Northern oriole	*Icterus galbula*	WO
House finch	*Carpodacus mexicanus*	GP, P, WO, T
Evening grosbeak	*Coccothraustes vespertinus*	WO, T
Mammals		
Pygmy rabbit	*Brachylagus idahoensis*	T
Nuttall's cottontail	*Sylvilagus nuttallii*	T, P, WO, GP
Black-tailed hare	*Lepus californicus*	WO, P
Least chipmunk	*Tamias minimus.*	T, P
Townsend's ground squirrel	*Spermophilus townsendii*	T, P, WO, GP
California ground squirrel	*Spermophilus beecheyi*	T, P, WO, GP
Golden-mantled ground squirrel	*Spermophilus lateralis*	T
Yellow-bellied marmot	*Marmota flaviventris*	WO, P, T
Northern pocket gopher	*Thomomys talpoides*	P
Ord's kangaroo rat	*Dipodomys ordii*	P
Dusky-footed woodrat	*Neotoma fuscipes*	P
Bushy-tailed woodrat	*Neotoma cinerea*	T
Coyote	*Canis latrans*	T, WO, GP, P
Badger	*Taxidea taxus*	T, WO, P
Mule deer	*Odocoileus hemionus*	WO, T, GP, P
Pronghorn	*Antilocapra americana*	T, P
Amphibians and Reptiles		
Western fence lizard	*Sceloporus occidentalis*	P, WO, GP, T
Sagebrush lizard	*Sceloporus graciosus*	P, WO, GP, T
Racer	*Coluber constrictor*	T
Garter snake	*Thamnophis elegans*	T
Bullfrog	*Rana catesbeiana*	WO

*Linear types in which species were observed during surveys.

WO = water pipeline supply route overland
GP = gas pipeline supply route
T = electric transmission line route
P = Facility site

APPENDIX C

Screening-Level Ecological Risk Assessment

Screening-Level Ecological Risk Assessment COB Energy Facility, Bonanza, Oregon

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DATE: October 2, 2003

1. Introduction

A screening-level ecological risk assessment (ERA) following U.S. Environmental Protection Agency (EPA) and Oregon Department of Environmental Quality (ODEQ) guidance was conducted to determine the potential risk to plants, soil invertebrates, and wildlife from air emissions at the COB Energy Facility, and the potential risk of using process wastewater to irrigate 31 acres of pasture and to improve grazing forage yield in areas currently without irrigation. Because there is an active bald eagle nesting area near McFall Reservoir, located approximately 6 miles south of the proposed facility location, the U.S. Fish and Wildlife Service (USFWS) has expressed concern about the potential impacts of the air emissions of the Energy Facility on bald eagles and their habitat. Two endangered fish species (shortnose sucker and Lost River sucker) that historically have been found in the Lost River, located 2 miles north of the Energy Facility, and one plant species (Applegate's milk-vetch) are of concern as well.

The screening-level ERA was conducted as part of the biological assessment (BA) to address the potential risk from air emissions (and subsequent deposition to surface water) to aquatic organisms and to the bald eagle (with exposure via food web transfer). Upland areas surrounding the Energy Facility site also were evaluated for possible risks to terrestrial plants, soil invertebrates, and terrestrial birds and mammals resulting from terrestrial deposition of air emissions and from reuse of the process wastewater for irrigation.

The procedures used in conducting the ERA are consistent with those described in the following ODEQ and EPA guidance documents:

- Guidance for Ecological Risk Assessment: Level II Screening Level Values (ODEQ, 2001)
- *Framework for Ecological Risk Assessment* (EPA, 1992a)
- *Final Guidelines for Ecological Risk Assessment* (EPA, 1998a)

Ecological risks were evaluated on the basis of conservative assumptions, maximum estimated media concentrations, and screening toxicity values. As is appropriate for a screening-level assessment, risk is not discussed in terms of the potential to cause risk, but in terms of passing or failure to pass the screening evaluation. This screening assessment was based on conservative assumptions such that constituents that passed the screen can be considered to pose no significant risk to ecological receptors. Failure to pass the screen, however, cannot be concluded to represent the presence of risk. Rather these results indicate that available data are insufficient to support a conclusion that ecological risks are absent. Constituents that failed the screen were reevaluated using more realistic assumptions.

This ERA is presented in four sections: problem formulation, exposure assessment, effects assessment, and risk characterization.

2. Problem Formulation

The problem formulation is the first and most critical component of any risk assessment. It involves identifying the problem and chemicals to be addressed, describing the affected site, selecting assessment and measurement endpoints, and developing a site conceptual model and data quality objectives. The problem formulation serves to provide direction and focus to the assessment process.

2.1 Site Description

This section summarizes the location and environmental setting of the Energy Facility (see Sections 2 and 4 of the BA for a more detailed discussion). Briefly, the Energy Facility site is located 3 miles south of Bonanza, Oregon, and 34 miles east of Klamath Falls, Oregon. The Lost River is located approximately 2 miles north of the Energy Facility site and Bryant Mountain is located approximately 1 mile south of the Energy Facility site. Various habitat types within the expected impact area of the Energy Facility include western juniper woodland, Ponderosa pine forest, sagebrush-steppe, ruderal areas, agricultural lands, and several riparian areas associated with the water resources in the area (e.g., Klamath River and tributaries).

2.2 Contaminants of Potential Ecological Concern

Contaminants of potential ecological concern (COPECs) are those chemicals that are present at the site in concentrations that may exceed toxicity thresholds for ecological receptors. This ERA evaluates estimated media concentrations modeled from the air emissions predicted from the natural gas combustion at the Energy Facility and estimated soil concentrations from land application of process wastewater. Because the primary deposition area for air emissions is outside the Energy Facility site (see Figure 1), the deposition from air emissions is not expected to overlap with the process wastewater application area. These two inputs, therefore, were considered separately and were not considered to be additive in soil. Methods used for estimating soil and water concentrations are described below.

2.2.1 Air Emissions

Predicted hazardous air pollutants (HAPs) and their estimated annual emissions are presented in Table 1 along with the estimated annual emissions of particulate matter under 10 microns (PM_{10}). Additionally, the distribution of ground-level air concentrations of PM_{10} was modeled for a radius of 6 miles around the Energy Facility. The area predicted to have the highest PM_{10} concentrations is depicted in Figure 1. Although organic constituents are estimated in the air emissions (see Table 1), all the organic HAPs are in the vapor phase (vapor phase fraction 100 percent; EPA, 1999), and thus are not expected to have significant deposition to soil or water in the Energy Facility area. Most of the polycyclic aromatic hydrocarbons (PAHs) also are in the vapor fraction (greater than 75 percent; EPA, 1999), and will not have significant deposition in the modeling domain. As a result, the organic HAPs are assumed to vaporize and are not evaluated in this ERA. Metals are of primary concern because of their potential for deposition and low, if any, loss rate from soil and water. These metals include arsenic, cadmium, chromium, cobalt, manganese, mercury, and nickel.

To determine air concentrations of the metals in soil and surface water, the concentration of PM_{10} was multiplied by the ratio of PM_{10} annual emission rate and annual emission rate of the metal. This approach was based on the assumption that all metals are a fraction of the PM_{10} air concentration. The estimated ground-level air concentration of each metal then was used to calculate soil and water concentrations using the following equation from the EPA combustion guidance (EPA, 1998b):

$$Cs = 100 * [(Dydw + Dyww)/(Zs*BD)]*tD$$

Where,

Cs = average soil or water concentration over exposure duration (mg/kg or mg/L),

100 = units conversion factor (mg-m^2/kg-cm^2),

Dydw = deposition rate of dry matter (g/m^2-yr),

Dyww = deposition rate of wet matter (g/m^2-yr),

Zs = soil or water mixing zone depth (cm) = 1 cm for soil, 609.6 cm for surface water in a generic reservoir, and 60.96 cm for surface water in a generic river,

BD = soil or water bulk density (g/cm^3) = 1.5 g/cm^3 for soil and 1 g/cm^3 for water,

tD = time over which deposition occurs (time period of combustion) (yr) = 30 yrs.

These calculations were based on the following conservative assumptions:

- A literature-derived deposition rate of 0.02 m/s (CAPCOA, 1993). This rate includes both dry and wet deposition and is highly conservative. In some cases, it has overestimated deposition by an order of magnitude (Howroyd, 1984).
- The value for "(Dydw + Dyww)" in the above equation was calculated by multiplying the predicted air concentration of the COPEC at ground level by the deposition rate. Although McFall Reservoir and Lost River are outside the area predicted to receive the highest concentration of PM_{10} (see Figure 1), the maximum predicted air concentration was used to estimate soil and surface water concentrations.
- No volatilization of metals occurs that results in 100 percent deposition of emissions. This is especially conservative for mercury because 100 percent of elemental mercury remains in the vapor fraction, and 85 percent of mercuric chloride is generally volatile (EPA, 1999).
- After deposition, no loss to processes, such as erosion, occurs.
- A mixing depth of 1 cm for soil was used as recommended in the combustion guidance (EPA, 1998b). For water bodies, a mixing depth of 20 feet (609.6 cm) for a generic

reservoir (surrogate for McFall Reservoir) and 2 feet (60.96 cm) for a generic river (surrogate for Lost River) were selected on the basis of best professional judgment given the latitude and elevation of areas surrounding the Energy Facility.

Table 2 presents summary statistics for predicted concentrations of each COPEC.

2.2.1 Process Wastewater Application

Maximum soil concentrations for the process wastewater application area were calculated from the predicted constituents in the process wastewater at 75 percent recovery (see Table 3). Aluminum, antimony, arsenic, barium, beryllium, cadmium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium, silver, thallium, tin, and zinc were not detected in the aquifer source water; however, these metals are common in groundwater and likely exist at concentrations below the method reporting limits (MRLs). Therefore, as a conservative assumption, the MRLs for these metals were assumed to represent their concentration in the aquifer source water. Concentrations of these metals were predicted in the process wastewater by multiplying the MRL by a factor (1.954) based on the ratio of raw aquifer water concentration to predicted reject water concentration for metals with detected values (see Table 3). Maximum soil concentrations (MSC) were determined using the following equation:

$$\text{MSC} = \frac{(PWC * AWP * L)}{(AA * MD * BD)}$$

Where,

MSC = maximum soil concentration (mg/kg)

PWC = predicted wastewater concentration of constituent (mg/L),

AWP = annual wastewater production (24.3 million gallons or 1,985,500 L),

L = life-span of the energy plant (30 years),

AA = wastewater application area (31 acres or 125,452 m^2),

MD = soil mixing depth for agricultural lands (20 cm or 0.2 m; EPA, 1998b),

BD = bulk density for soil (literature-derived value of 1,500 kg/m^3; EPA, 1998b).

This calculation assumes that constituents accumulate during the 30-year life span of the Energy Facility with no loss from biodegradation, erosion, leaching, or other biotic or abiotic loss mechanisms (see Table 3 for estimated MSCs).

2.2.3 Background Soil Concentrations

Soil concentrations derived from air emissions or process wastewater application represent incremental exposure. Plants, soil invertebrates, and wildlife also are exposed to background concentrations of many of the COPECs. Therefore, background values alone were also compared to screening benchmarks to determine the contribution of background to the total risk estimate. For this ERA, background values for Klamath County as reported by the U.S. Geological Service (USGS) (Boerngen and Shacklette, 1981) were used, as were

Washington statewide background values (San Juan, 1994) when USGS values were lacking. These values are presented in the risk characterization.

2.3 Assessment Endpoints and Measures of Exposure and Effects

Assessment endpoints are the ecological resources (e.g., potential receptors) that are present at a site and are to be protected. Measures of exposure and effects are the measures evaluated to provide an indication of whether assessment endpoints are sufficiently exposed such that adverse effects may have occurred or are likely to occur.

The areas surrounding the Energy Facility contain a variety of habitats, including riverine systems that support shortnose suckers, Lost River suckers, and bald eagles, which are all federally listed threatened or endangered species. Maintenance of resident aquatic resources is important to the success of these species. Moreover, maintenance of resident terrestrial habitats also is important to bald eagles, which use upland areas during the winter months when lakes and rivers are frozen (Brown and Amadon, 1968). Although Applegate's milk-vetch has been identified as a federally threatened or endangered species endemic to the area, this plant has not been observed in the area of major air emission deposition or in the process wastewater application area. EPA (1992a) identifies four criteria to consider when selecting assessment endpoints. The following is a summary of these criteria and their relationship to the assessment endpoints for the Energy Facility:

- Societal value: Threatened and endangered species (e.g., shortnose sucker, Lost River sucker, and bald eagle) are valued by society as evidenced by special protective legislation.
- Environmental policy goals: Threatened and endangered species (e.g., shortnose sucker, Lost River sucker, and bald eagle) are protected at the individual level.
- Ecological relevance: Aquatic organisms (aquatic plants, invertebrates, and fish) are integral components of the riverine ecosystem present in the Energy Facility area and plants, soil invertebrates, and terrestrial birds and mammals are integral components of the terrestrial ecosystem present in the Energy Facility area.
- Susceptibility to the stressor: Research has shown that aquatic organisms, plants, soil invertebrates, birds, and mammals may be adversely affected by exposure to the COPECs.

Aquatic organisms, terrestrial plants, soil invertebrates, birds, and mammals are potentially sensitive to contaminants and are considered ecologically important. Complete definitions of an assessment endpoint have three components (Suter et al., 2000): the entity, the attribute, and a level of effect. Table 4 summarizes the appropriate assessment endpoints and measures of exposure and effects.

Aquatic organisms, including fish, and bald eagles were evaluated for the aquatic pathways associated with air emissions. Terrestrial pathways for both air emissions deposition and irrigated reuse of process wastewater were evaluated using terrestrial plants, soil invertebrates, and terrestrial birds and mammals as receptors. Specific bird and mammal receptors included the western meadowlark and the deer mouse for the terrestrial assessment and the bald eagle for the aquatic assessment. Western meadowlarks and deer mice have foraging behaviors that are closely associated with the soil and, therefore, are likely to be highly exposed to COPECs in soil. Table 5 outlines life-history parameters for these species.

2.4 Conceptual Site Model

The conceptual site model (CSM) is a description of predicted relationships between ecological receptors and the COPEC to which they might be exposed.

An exposure pathway can be described as the physical course that a COPEC takes from the point of release to a receptor. An exposure pathway is complete (i.e., there is exposure) if there is a way for the receptor to take in chemicals through ingestion, inhalation, or dermal absorption. To be complete, an exposure pathway must have all the following components:

- Chemical source
- Mechanism for chemical release
- Environmental transport medium
- Exposure point
- Feasible route of intake

In the absence of any of these components, an exposure pathway is considered incomplete, and, by definition, there can be no risk associated with that particular exposure pathway. Exposure can occur when chemicals migrate from their source to an exposure point (i.e., a location where receptors can come into contact with the chemicals) or when a receptor moves into direct contact with chemicals or contaminated media.

2.4.1 Air Emissions

For purposes of this ERA, the air emissions from natural gas combustion at the Energy Facility are considered the primary source of the COPECs. These COPECs may deposit from air to the soil and surface water within the areas surrounding the Energy Facility. Significant transport of COPECs from the deposition area is not expected. Soil and surface water are the affected media and both aquatic and terrestrial routes of exposure to the COPECs are evaluated in this ERA. Receptors are potentially exposed by way of root or foliar uptake, dermal contact, inhalation, direct ingestion, and ingestion of prey items.

A wide variety of wildlife is supported by the Klamath Basin mix of habitats, and both terrestrial and aquatic routes of exposure to COPECs exist. Contaminants in water may be directly bioaccumulated by aquatic organisms resident in water bodies located in the vicinity of the Energy Facility, and contaminants in soil may be directly bioaccumulated by terrestrial plants or soil invertebrates. Both aquatic and terrestrial wildlife may be exposed directly to contaminants in soil or surface water by direct ingestion, by dermal contact, or by the inhalation of wind-borne particles. Little information is available on foliar uptake and inhalation routes, and exposure via these routes is expected to be minimal; therefore, these pathways will not be evaluated. Although the dermal contact route of exposure exists for many birds and mammals, dermal exposure is likely to be low because of the presence of protective dermal layers (e.g., feathers, fur, scales). Wildlife also may receive contaminant exposure through food-web transfer of chemicals from lower trophic levels (e.g., plants to herbivores, plants and prey animals to omnivores) and this is expected to be the primary exposure route for wildlife.

2.4.2 Process Wastewater Application

For purposes of this ERA, the process wastewater from the Energy Facility is considered the primary source of the COPECs. These COPECs are transferred to soil in the 31-acre pasture area. Process wastewater will only be applied 8 months of the year and will not be applied during the winter. Soil is the affected medium and only terrestrial routes of exposure to the COPECs are evaluated in this ERA. No aquatic routes of exposure are expected. Receptors are potentially exposed via root and/or foliar uptake, dermal contact, inhalation, direct ingestion, and ingestion of prey items.

Contaminants in soil may be directly bioaccumulated by terrestrial plants or soil invertebrates. Terrestrial birds and mammals may be exposed directly to contaminants in soil or surface water by direct ingestion, by dermal contact, or by the inhalation of wind-borne particles. Little information is available on foliar uptake and inhalation routes and exposure via these routes is expected to be minimal; therefore, these pathways will not be evaluated. Although the dermal contact route of exposure exists for many birds and mammals, dermal exposure is likely to be low because of the presence of protective dermal layers (e.g., feathers, fur, scales). Wildlife also may receive contaminant exposure through food-web transfer of chemicals from lower trophic levels (e.g., plants to herbivores, plants and prey animals to omnivores) and this is expected to be the primary exposure route for wildlife.

3. Exposure Assessment

3.1 Aquatic Organisms

Aquatic organisms (aquatic plants, invertebrates, fish) experience exposure based on concentrations in water (i.e., exposure is water-mediated). Water-mediated exposure occurs as a consequence of living in a contaminated medium. Uptake of COPECs can be through the skin (dermal), through the gills, or through the diet, including ingestion of contaminated water and food. Water-mediated exposure to aquatic organisms is measured as a function of the concentration of contaminants in water (milligrams COPEC per liter water [mg/L]). Water-mediated exposure is used because most information on the effects of contaminants on aquatic organisms (described in Section 4.1) has been obtained from experiments where the exposure to contaminants was reported as a function of the concentrations of contaminants in water. To be conservative, the maximum estimated water concentration for each surface water type (i.e., generic reservoir and generic river) was selected as the suitable exposure point concentration.

3.2 Terrestrial Plants

Terrestrial plants experience exposure based on concentrations in soil (i.e., exposure is soil-mediated). Soil-mediated exposure occurs as a consequence of living in a contaminated medium. For plants, uptake of COPECs can be through roots. Soil-mediated exposure to plants is measured as a function of the concentration of contaminants in soil (milligrams lead per kilogram soil [mg/kg]). Soil-mediated exposure is used because most information on the effects of contaminants on plants (described in Section 4.2) has been obtained from experiments where the exposure to contaminants was reported as a function of the concentrations of contaminants in soil. Because plants are not mobile and to be highly conservative, the maximum estimated concentration was selected as the suitable exposure point concentration.

3.3 Soil Invertebrates

Like plants, soil invertebrates also experience soil-mediated exposure. Uptake of COPECs can be through the skin (dermal), or through the diet, including ingestion of contaminated soil and food. As with plants, most information on the effects of contaminants on soil invertebrates (described in Section 4.3) has been obtained from experiments where the exposure to contaminants was reported as a function of the concentrations of contaminants in soil. Therefore, the focus of the exposure characterization for soil-mediated exposures is the derivation of soil exposure point concentrations. Because mobility of terrestrial invertebrates is low, the maximum concentration was selected as the suitable exposure point concentration.

3.4 Birds and Mammals

Birds and mammals experience exposure through multiple pathways including ingestion of abiotic media (soil, sediment, and surface water) and biotic media (food) as well as inhalation and dermal contact. To address this multiple pathway exposure, modeling is required. Generally, the end product or exposure estimate for birds and mammals is a dosage (amount of chemical per kilogram receptor body weight per day [mg/kg/d]) rather than a media concentration as is the case for the other receptor groups (aquatic organisms, terrestrial plants, and soil invertebrates). This is a function of both the multiple pathway approach as well as the typical methods used in toxicity testing for mammals. However, ODEQ has developed soil screening-level values for birds and mammals and water screening-level values for birds for some contaminants based on conservative assumptions (ODEQ, 2001). These values are intended to be protective of terrestrial birds and mammals and aquatic birds, respectively, and were used as available. To be conservative, the maximum concentration was selected as the suitable exposure point concentration for comparison to the ODEQ screening values.

If no screening value was available for a COPEC, or a screening value was exceeded, receptor-specific exposure was calculated and compared to literature-derived toxicity values. Moreover, receptor-specific exposure was calculated for bald eagles because it is a special-status species. Summaries of total (i.e., sum over all pathways) and partial (pathway-specific) exposure estimates, as needed, are presented and compared to toxicity values in Section 5. The model used for estimating receptor-specific exposure and associated assumptions is described below.

Model

The general form of the model (Suter et al., 2000) used to estimate exposure of birds and mammals to COPECs in soil, surface water, and food items is as follows:

$$E_t = E_o + E_d + E_i$$

Where:

E_t = the total chemical exposure experienced by wildlife

E_o, E_d, and E_i = oral, dermal, and inhalation exposure, respectively

Oral exposure occurs through the consumption of contaminated food, water, or soil. Dermal exposure occurs when contaminants are absorbed directly through the skin. Inhalation exposure occurs when volatile compounds or fine particulates are inhaled into the lungs.

Although methods are available for assessing dermal exposure to humans (EPA, 1992b), data necessary to estimate dermal exposure generally are not available for wildlife (EPA, 1993). Similarly, methods and data necessary to estimate wildlife inhalation exposure are poorly developed or generally not available (EPA, 1993). Therefore, for the purposes of this ERA, both dermal and inhalation exposure are assumed to be negligible. As a consequence, most exposure must be attributed to the oral exposure pathway. There are no surface water sources on the 31-acre process wastewater application area and, given the arid environment, all water applied to soil is assumed to be rapidly absorbed; therefore, water ingestion is considered an incomplete or insignificant exposure pathway. In contrast, deposition from air emissions is likely to occur in surface waters; therefore, water ingestion is included in the exposure calculations for air emission deposition. By replacing E_o with a generalized exposure model modified from Suter et al. (2000), the previous equation was rewritten as follows:

$$E_j = \left[Water_j \times WIR\right] + \left[Soil_j \times P_s \times FIR\right] + \left[\sum_{i=1}^{N} B_{ij} \times P_i \times FIR\right]$$

Where:

E_j = total exposure (mg/kg/d)

$Water_j$ = concentration of chemical (j) in water (mg/L)

WIR = species-specific water ingestion rate (L water/kg body weight/d)

$Soil_j$ = concentration of chemical (j) in soil (mg/kg)

P_s = soil ingestion rate as proportion of diet

FIR = species-specific food ingestion rate (kg food/kg body weight/d)

B_{ij} = concentration of chemical (j) in biota type (i) (mg/kg)

P_i = proportion of biota type (i) in diet

Assumptions

To establish parameters for the exposure model, various assumptions were necessary. These assumptions are outlined below.

Exposure Point Concentrations. As with the comparisons to ODEQ screening values, a highly conservative approach was taken and the maximum estimated concentration was incorporated into the exposure model as the exposure point concentrations for soil and surface water. Because there is primary concern for bald eagles utilizing the McFall Reservoir, the generic reservoir surface water values (maximum concentrations) were used as exposure point concentrations for bald eagles.

Life History Parameters. The specific life-history parameters required to estimate exposure of birds and mammals to COPECs include body weight, ingestion rate of food, ingestion rate of water (for air emissions analysis only), dietary components and percentage of the overall diet represented by each major food type, and approximate amount of soil that may be incidentally ingested based on feeding habits. These parameters, as well as home range information, were obtained from the literature and are presented in Table 5.

Bioaccumulation Values. Measurements of concentrations of COPECs in wildlife foods are a critical component for the estimation of oral exposure in birds and mammals. Although the preferred data are direct measurements of concentrations in samples collected from the site, such data were not available in the vicinity of the Energy Facility. Therefore, literature-reported bioaccumulation factors (BAFs), regressions, or Kow-based models for terrestrial food items (foliage and insects) and literature-reported bioconcentration factors (BCFs) for aquatic food items were used.

BAFs or regressions were available for foliage (Bechtel-Jacobs, 1998; CH2M HILL, 2002), and insects (CH2M HILL, 2002) for the inorganics, models (K_{ow}-based) from EPA (2000) were used to estimate bioaccumulation factors (BAFs) for phenol in foliage and earthworms. The earthworm model was used as a surrogate for insects. To be conservative, the fraction of organic carbon required for the earthworm bioaccumulation model was assumed to be 1 percent. No foliage BAFs were available for cyanide, silver, thallium, or tin and no insect BAFs were available for cyanide, or tin; therefore, a BAF of one was assumed for these COPECs. BCFs were available for fish (Sample et al., 1997) for all COPECs, except cobalt and manganese. A BCF of one was assumed for these two COPECs. Table 6 summarizes the BAFs and BCFs used in the ERA.

4. Characterization of Ecological Effects

4.1 Aquatic Organisms

Screening-level toxicity values for aquatic organisms are provided by ODEQ guidance (ODEQ, 2001) and are shown in Table 7. For most cases, these values are the same as the National Ambient Water Quality Criteria (EPA, 2002) or chronic values developed at the Oak Ridge National Laboratory (ORNL) (Suter and Tsao, 1996). These values are intended to protect 95 percent of aquatic species, 95 percent of the time. Screening values are only shown for the COPECs associated with air emissions. An aquatic pathway is not complete for the process wastewater application.

4.2 Terrestrial Plants

Screening-level toxicity values for terrestrial plants are provided by ODEQ guidance (ODEQ, 2001) and are shown in Table 7. Most of these screening values are from the ORNL plant benchmarks report (Efroymson et al., 1997a). The protection of terrestrial plant communities from a 20 percent reduction in growth, reproduction, or survival is an assessment endpoint in this ERA. Therefore, benchmarks used to determine risk to this receptor group must be based on adverse effects related to these endpoints. The ORNL plant benchmarks were developed from studies that demonstrated at least a 20 percent reduction in the growth or yield of test plant species, which is consistent with the goals of the ERA.

Additionally, growth and yield are important to plant populations and to the ability of the vegetation to support higher trophic levels; therefore, these are ecologically significant responses (Efroymson et al., 1997a).

4.3 Soil Invertebrates

Single-chemical screening-level toxicity values for soil invertebrates are provided by ODEQ guidance (ODEQ, 2001) and are shown in Table 7. Most of these screening values are from the ORNL soil invertebrate benchmarks report (Efroymson et al., 1997b) and are represented primarily by earthworms. The protection of terrestrial invertebrate communities from a 20 percent reduction in growth, reproduction, or survival is an assessment endpoint this assessment. Therefore, benchmarks used to determine risk to this receptor group must be based on adverse effects related to these endpoints. The ORNL soil invertebrate benchmarks were developed from studies that demonstrated at least a 20 percent reduction in the growth or survival of test invertebrate species, which is consistent with the goals of the ERA.

4.4 Birds and Mammals

Screening-level values for birds and mammals provided by ODEQ (ODEQ, 2001) were used as available in the ERA and are presented in Table 7. For birds, cobalt, iron, silver, thallium, and tin were lacking ODEQ screening values, but studies from which benchmarks could be developed for these metals were available. Similarly, iron, silver, tin, cyanide, and phenol benchmarks were developed for mammals from other sources. No data for birds were available for development of benchmarks for cyanide or phenol. Unlike the ODEQ screening values, which are presented as mg constituent per kg soil, these benchmarks are presented as a dose (mg constituent/kg body weight/day) to the receptor and were selected as described below.

Single-chemical toxicity data for birds and mammals consist of no observable adverse effect levels (NOAEL) or lowest observable adverse effect levels (LOAEL) derived from toxicity studies reported in the literature. The benchmarks for birds and mammals were obtained from several sources, including wildlife toxicity reviews, literature searches, wildlife benchmarks developed at ORNL (Sample et al., 1996), the EPA Region IX Biological Technical Assistance Group (BTAG) toxicity reference values (TRV) developed for the U.S. Navy (EFA West, 1998), and a Review of the Navy-EPA Region IX BTAG TRVs for Wildlife (CH2M HILL, 2000). Appropriate studies were selected based on the following criteria:

- Studies were of chronic exposures or exposures during a critical life-stage (i.e., reproduction).
- Exposure was oral through food, to ensure data were representative of oral exposures expected for wildlife in the field.
- Emphasis was placed on studies of reproductive impacts, to ensure relevancy to population-level effects.
- Studies presented adequate information to evaluate and determine the magnitude of exposure and effects (or no effects concentrations).

Multiple toxicity studies were available for birds and mammals for several analytes. Toxicity studies were selected to serve as the primary toxicity value if exposure was chronic or during reproduction, the dosing regime was sufficient to identify both a NOAEL and a LOAEL, and the study considered ecologically relevant effects (i.e., reproduction, mortality, growth). If multiple studies for a given COPEC met these criteria, the study generating the lowest reliable toxicity value was selected to be the primary toxicity value. Primary toxicity values were used for all initial evaluations of the exposure estimates and are highlighted in Table 8. Information concerning assumptions made as part of the extraction of data from each study is presented in the one attachment to this memorandum.

NOAELs and LOAELs for avian and mammalian receptors were estimated from literature data using allometric scaling methods presented in Sample et al. (1996) and Sample and Arenal (1999). Using the following equation, NOAEL or LOAEL for wildlife ($NOAEL_w$ or $LOAEL_w$) were determined for each species:

$$NOAEL_w = NOAEL_t \left(\frac{BW_t}{BW_w} \right)^{1-b} \text{ or } LOAEL_w = LOAEL_t \left(\frac{BW_t}{BW_w} \right)^{1-b}$$

where:

$NOAEL_t$	=	the NOAEL for a test species (obtained from the literature),
$LOAEL_t$	=	the NOAEL for a test species (obtained from the literature),
BW_t and BW_w	=	the body weights (in kg) for the test and wildlife species, respectively, and
b	=	the class-specific allometric scaling factor.

Scaling factors of 0.94 and 1.2 were applied for mammals and birds, respectively (Sample and Arenal, 1999). Table 9 presents these receptor-specific NOAELs and LOAELs.

5. Risk Characterization

In the risk characterization, exposure and effects data are combined to draw conclusions concerning the presence, nature, and magnitude of effects that may exist at the site. For all receptors (i.e., aquatic organisms, terrestrial plants, soil invertebrates, and birds and mammals), only literature-derived benchmarks were available. These were compared to maximum soil or water concentrations or dose based on maximum soil or water concentration to determine hazard quotients (HQs = exposure measure/effects measure) for each COPEC. Screening-level benchmarks are conservative; therefore, COPECs that are below these thresholds pass the screen and are not considered in future evaluations. However, HQs greater than one indicate a failure to pass the screen. Failure to pass the screen, however, cannot be concluded to represent the presence of risk. Rather, these results indicate that available data are insufficient to support a conclusion that ecological risks are absent. Constituents that failed the screen were reevaluated using more realistic assumptions.

Results of the screening evaluations for deposition from air emissions and process wastewater application are discussed below. Uncertainties that may influence these screening-level results are summarized in Section 5.3.

5.1 Air Emissions

Screening results for incremental, background, and total soil concentrations and incremental surface water concentrations (generic reservoir and generic river) against ODEQ screening values are presented in Tables 10 and 11, respectively. Table 12 presents bird and mammal screening evaluations based on receptor-specific parameters for COPECs that failed the ODEQ screen (chromium for birds), for COPECs lacking ODEQ screening values (cobalt for birds), and for bald eagles.

For terrestrial receptors (i.e., plants, soil invertebrates, and birds and mammals), chromium, manganese, and nickel failed to pass the screening evaluation when total (incremental + background) concentrations were evaluated (Table 10). Chromium exceeded the ODEQ screening values for plants, soil invertebrates, and birds; manganese exceeded the screening value for plants and soil invertebrates, and nickel exceeded the screening value for plants. However, in all cases, these exceedances were driven by background concentrations and no HQs greater than one were observed based on incremental concentrations. Because total chromium concentrations exceeded the ODEQ benchmark (HQ = 11.25) for birds and because no ODEQ avian screening value was available for cobalt, these COPECs were further evaluated using receptor-specific parameters to calculate exposure to western meadowlarks (see Table 11). In this evaluation, estimated oral exposure to chromium and cobalt was less than literature-derived benchmarks for these COPECs (see Table 11). Therefore, potential risks from chromium, manganese and nickel to plants, soil invertebrates, and birds are considered to be negligible.

Estimated maximum concentrations of all COPECs under both the generic reservoir and generic river scenarios were below ODEQ benchmarks for aquatic biota and aquatic birds (see Table 11). Therefore, no risk is expected from any of these COPECs. Because no ODEQ aquatic bird screening value was available for cobalt, this COPEC was further evaluated using receptor-specific parameters to calculate exposure (see Table 11). Additionally, exposure calculations using receptor-specific parameters were performed for bald eagles because it is a special-status species that is of special concern within the deposition area of air emissions from the Energy Facility (see Table 11). None of the COPECs evaluated further exceeded oral exposure benchmarks for birds (i.e., all HQs were less than one) (see Table 11). Thus, deposition of metals from air emissions is considered to present no risk to aquatic organisms or bald eagles using reservoirs in the vicinity of the Energy Facility. Moreover, no risk to aquatic organisms, including the shortnose sucker and Lost River sucker, or birds using the riverine habitats in the vicinity of the Energy Facility is expected.

5.2 Process Wastewater Application

Screening results for incremental, background, and total soil concentrations against ODEQ screening values are presented in Table 13. Bird and mammal screening evaluations for COPECs lacking ODEQ values are presented in Table 14.

As indicated in Table 13, several process wastewater constituents (aluminum, barium, boron, chromium III, copper, fluoride, iron, manganese, molybdenum, and nickel) failed to pass the screening evaluation (i.e., HQs greater than one for any receptor) when total (incremental + background) concentrations were evaluated. However, the exceedances of all but boron and molybdenum were driven by background concentrations. It is notable that the ODEQ plant screening value for iron is not a soil concentration, but in fact, represents the screening value for iron in solution. Because it is not applicable to soil, this benchmark was considered inappropriate for use in the screening evaluation. Although risk to plants from iron exposure is uncertain, no incremental risk was found for soil invertebrates, birds, and mammals.

Additionally, incremental exposure to iron is only 0.02 percent of the background exposure and is likely insignificant compared to background. Of the constituents evaluated separately for birds and mammals (dose calculations), only iron exceeded the NOAELs with HQs of 17 and 3,139 for meadowlarks and deer mice, respectively (see Table 14). As with the evaluation in Table 13, these exceedances were driven by background iron concentrations with no exceedances of the toxicity reference values based on wastewater discharge alone. HQs for incremental exposure to iron were 0.003 and 0.504 for meadowlarks and deer mice, respectively. Therefore, the incremental exposure to plants, soil invertebrates, birds, and mammals from the process wastewater application is expected to be minor for all constituents, except for boron and molybdenum exposures to plants and boron exposures to invertebrates. Constituents for which toxicity benchmarks are lacking were not evaluated and remain an uncertainty. Additionally, salts and total dissolved solids (TDS) were evaluated elsewhere in the BA.

Estimated maximum incremental boron concentrations in soil were 93 times the screening value of 0.5 mg/kg. However, the screening value represents the toxicity level for highly sensitive plant species. For boron-tolerant species (e.g., alfalfa), toxicity thresholds are approximately 2 to 4 mg/kg (Brown et al., 1983). This reduces the HQ from 53.4 to approximately 23.3 to 11.7 for the boron-tolerant species selected for planting in the application area. Moreover, less than 5 percent of the total boron in soil is available for uptake to plants (Eisler, 2000), reducing the estimated incremental exposure from 26.7 mg/kg to 1.33 mg/kg and the total exposure from 46.7 to 2.33 mg/kg. Though these concentrations still exceed the screening level derived for sensitive plants species, they are below concentrations associated with toxic effects to boron-tolerant plants when considering boron bioavailability. Boron concentrations adjusted for bioavailability are also below the screening level for invertebrates.

Molybdenum is an essential micronutrient that is not highly toxic to plants, but bioaccumulates in plant tissue and is generally of concern to higher trophic organisms (Eisler, 2000). Ruminants (e.g., cattle and sheep) in particular can be sensitive to molybdenum exposure in forage because excess molybdenum may result in a copper deficiency (Eisler, 2000). However, the maximum estimated total molybdenum concentration in soil did not exceed the screening benchmarks for birds and mammals and is therefore unlikely to pose risk to these receptors.

Although the molybdenum benchmark for plants was exceeded, risk to terrestrial plants from molybdenum exposure is considered low because of the low exceedance of the screening value (HQ = 2.7 for total molybdenum). Additionally, the highly conservative assumptions applied to the risk estimation likely result in an overestimation of molybdenum exposure. First, molybdenum was not measured in the raw aquifer water and was therefore estimated using the minimum reporting limit. Moreover, the maximum soil concentration of molybdenum was estimated assuming a wastewater output of 24.3 million gallons based on a 72 percent capacity factor for the Energy Facility. The actual capacity of the Facility will likely be closer to 40 percent, resulting in the creation of 13.5 million gallons of wastewater. At 40 percent capacity, the estimated soil concentration of molybdenum from wastewater application would be reduced from 2.41 to 1.34 mg/kg, a value below the screening benchmark for plants. Finally, the calculation used to estimate soil concentrations from wastewater application assume that there is no loss due to abiotic or biotic factors. As a consequence, the calculated molybdenum concentration likely represents an overestimate of exposure to organisms.

5.3 Uncertainty Analysis

Uncertainties are inherent in all risk assessments. The nature and magnitude of uncertainties depend on the amount and quality of data available, the degree of knowledge concerning site conditions, and the assumptions made to perform the assessment. The following is a qualitative evaluation of the major uncertainties associated with this assessment, in no particular order of importance:

- Concentrations of COPECs in soil and surface water were wholly estimated on the basis of predicted concentrations of COPECs in air emissions and process wastewater from the Energy Facility. Although this uncertainty may result in underestimation of exposure (and risk), the conservative assumptions applied to air emission and process wastewater predictions, as well as the conservative assumptions used to convert these concentrations to soil and water concentrations, likely result in an overestimation of risk.
- Literature-derived values for bulk density of soil, soil and water mixing depths, and deposition rate of air emissions were used to calculate soil and water concentrations. The suitability of these literature values is unknown, although these are conservative values. Therefore, risk may be underestimated, but is likely overestimated.
- Based on best professional judgment, mixing depths of 20 feet for reservoirs and 2 feet for rivers were selected for estimating surface water concentrations from air emissions deposition. The suitability of these values is unknown. Consequently, risk may be over- or underestimated.
- Constituents in wastewater were estimated assuming a 72 percent capacity factor for the Energy Facility. It is more likely that the Facility will be operated at approximately 40 percent capacity. Therefore, wastewater concentrations and resulting risk are likely overestimated.
- Molybdenum, copper, and sulfur have complex interactions in soil that can result in increased or decreased toxicity to foraging animals. For example, excess molybdenum can cause a copper deficiency, though adequate molybdenum can decrease toxicity associated with excess copper. Because of the uncertainties in the risk estimation (e.g., copper and molybdenum were not detected in the raw aquifer water) and the complex nature of these constituents, it is uncertain whether risk was over- or underestimated for

copper and molybdenum, although effort was made to overestimate risk through the conservative set of assumptions.

- Data concerning soil ingestion rates for bird and mammal receptors were not available. As a consequence, the soil ingestion rates were estimated on the basis of assumed similarities to other species for which data were available. The suitability of these assumptions is unknown. Although this uncertainty may result in underestimation of exposure (and risk), it is more likely that exposure and risk are overestimated.

- No life history data specific to the COB Energy Facility area were available; therefore, exposure parameters were either modeled on the basis of allometric relationships (e.g., food ingestion rates) or were based on data from the same species in other portions of its range. Because diet composition as well as food, water, and soil ingestion rates can differ among individuals and locations, published parameter values may not accurately reflect individuals present at the site. As a consequence, risk may be either overestimated or underestimated.

- No site-specific data on COPEC concentrations in fish, terrestrial plants, and soil invertebrates were available for wildlife exposure estimate calculations. Therefore, concentrations in these prey items were estimated from literature-reported bioaccumulation models (BCFs, 90^{th} Percentile BAFs, regressions, or Kow-based). The suitability of these bioaccumulation models is unknown. As a consequence, concentrations of COPECs in prey items of wildlife may be either greater than or less than data used in this assessment.

- Literature-derived toxicity data based on laboratory studies were used to evaluate risk to all receptor groups. It was assumed that effects observed in laboratory species were indicative of effects that would occur in wild species. The suitability of this assumption is unknown. Consequently, risk may be either overestimated or underestimated.

- Literature-derived toxicity data are not available for western meadowlarks, bald eagles, or deer mice. Therefore, laboratory studies on the effects of COPECs on test species (e.g., quail, chicken, mallard, rat, mouse, rabbit) were used to evaluate risks to these receptors. It was assumed that effects observed in these test species were indicative of effects that would occur in the receptor. However, sensitivity to COPECs can vary between species, and this variation may be even more varied between taxonomic groups (i.e., galliforms versus raptors). Consequently, risk may be either overestimated or underestimated.

- Toxicity data are not available for all COPECs considered in this ERA. As a consequence, COPECs for which toxicity data are unavailable were not evaluated. Exclusion of COPECs from evaluation underestimates aggregate risk.

- Bioavailability in the toxicity studies used for screening is generally high because many toxicity tests are performed using soluble salts of inorganic chemicals. Therefore, risk based solely on literature-derived toxicity values may be overestimated.

- Because toxicity data are not available for individual bird and mammal receptors, it was necessary to extrapolate toxicity values from test species to site receptor species. Although improved class-specific scaling factors were employed (Sample and Arenal, 1999), these factors are not chemical-specific and are based on acute toxicity data. As a consequence, risk may be either overestimated or underestimated.

- In this assessment, risks from COPECs each were considered independently (i.e., no ambient media toxicity data were available). Because chemicals may interact in an additive, antagonistic, or synergistic manner, evaluation of single-chemical risk may either underestimate or overestimate risks associated with chemical mixtures.

6. Conclusions

6.1 Air Emissions

For terrestrial receptors (i.e., plants, soil invertebrates, birds, and mammals), chromium, manganese, and nickel failed to pass the screening evaluation when total (incremental + background) concentrations were evaluated. However, in all cases, these exceedances were driven by background concentrations. Receptor-specific evaluation of chromium and cobalt exposure to birds resulted in no exceedances of literature-based toxicity thresholds. Therefore, exposure to arsenic, cadmium, cobalt, and mercury associated with air emissions from the Energy Facility poses no risk to plants, soil invertebrates, birds, and mammals, whereas potential risks to plants, soil invertebrates, and birds from exposure to chromium, manganese, and nickel are considered to be negligible.

None of the COPECs exceeded benchmarks for aquatic receptors; therefore, deposition of air emissions from the Energy Facility to surface water poses no risk to aquatic organisms, such as the shortnose sucker, Lost River sucker, and bald eagle.

6.2 Process Wastewater Application

Process wastewater constituents evaluated, except aluminum, barium, boron, chromium III, copper, fluoride, iron, manganese, molybdenum, and nickel, passed the screening evaluation and are considered to present no risk to ecological receptors. After further evaluation, background concentrations were found to be the primary driver for screening failures of aluminum, barium, chromium III, copper, fluoride, iron, manganese, and nickel, with negligible incremental contributions of these constituents to the risk estimation. Considering the bioavailability of boron to plants (less than 5 percent of total boron) substantially reduced the risk estimation for boron. Although both incremental and total (incremental + background) boron concentrations continued to exceed screening levels for sensitive plant species, incremental and total exposures were below toxicity thresholds for invertebrates and for boron-tolerant plant species when adjusted for boron bioavailability. Estimated maximum concentrations of molybdenum exceeded the soil benchmark for plants; however, risk to terrestrial plants from molybdenum exposure is considered low owing to the low exceedance of the screening value and the highly conservative assumptions applied to the risk estimation. Thus, none of the constituents evaluated are considered to present significant risk to ecological receptors.

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Tables

TABLE 1
Summary of Predicted Hazardous Air Pollutant (HAP) and Particulate Matter Less Than Ten Microns (PM_{10}) Emissions
Screening-Level Ecological Risk Assessment
COB Energy Facility, Klamath County, Oregon

	Facilitywide Emissions (tons/yr) *				
HAP	**CTGs and Duct Burners**	**Gas Heaters and Auxiliary Boilers**	**Fire Water Pump**	**Wellhead Emergency Generator**	**Total All Sources**
Benzene	1.7E-01	5.6E-04	5.0E-05	2.0E-05	0.17
Formaldehyde	3.0E+00	2.0E-02	6.3E-05	2.0E-06	2.98
Hexane	6.9E+00	4.8E-01			7.33
Naphthalene	2.0E-02	1.6E-04			0.02
Toluene	1.7E+00	9.1E-04	2.2E-05	7.2E-06	1.73
Acetaldehyde	5.3E-01		4.1E-05	6.5E-07	0.53
Acrolein	8.5E-02			2.0E-7	0.08
Ethylbenzene	4.2E-01				0.42
PAH	2.9E-02	1.4E-05	9.0E-06	5.4E-06	0.03
Xylenes (total)	8.5E-01		1.5E-05	5.0E-06	0.85
Dichlorobenzene	4.6E-03	3.2E-04			0.005
Arsenic	1.7E-03	5.3E-05			0.002
Cadmium	9.3E-03	2.9E-04			0.010
Chromium	1.2E-02	3.7E-04			0.012
Cobalt	7.1E-04	2.2E-05			0.001
Manganese	3.2E-03	1.0E-04			0.003
Mercury	2.2E-03	6.9E-05			0.002
Nickel	1.8E-02	5.6E-04			0.018
PM_{10}	2.5E+02	2.0E+00	1.7E-02	2.6E-03	247

* See Section 3.7.1.4 and Table 3.7.5 in the *COB Energy Facility Environmental Impact Statement* (BPA, 2003) for a summary of hazardous air pollutant (HAP) emissions.

CTG = combustion turbine generator

TABLE 2

Summary Statistics of Estimated Hazardous Air Pollutants (HAPs) and Particulate Matter Less Than Ten Microns (PM_{10})
Concentrations in Soil and Two Surface Water Sources (Generic Reservoir and Generic River) Over 30 Years
Screening-Level Ecological Risk Assessment
COB Energy Facility, Klamath County, Oregon

Analyte	Max	99% percentile	95% percentile	90% percentile	Mean	50% percentile (median)	Min
Soil (mg/kg) [a]							
Arsenic	0.012	8.4E-03	3.2E-03	1.8E-03	9.1E-04	4.9E-04	1.5E-05
Cadmium	0.061	0.042	0.016	9.1E-03	4.5E-03	2.4E-03	7.4E-05
Chromium	0.074	0.051	0.019	0.011	5.4E-03	2.9E-03	8.9E-05
Cobalt	6.1E-03	4.2E-03	1.6E-03	9.1E-04	4.5E-04	2.4E-04	7.4E-06
Manganese	0.018	0.013	4.8E-03	2.7E-03	1.4E-03	7.3E-04	2.2E-05
Mercury	0.012	8.4E-03	3.2E-03	1.8E-03	9.1E-04	4.9E-04	1.5E-05
Nickel	0.11	0.076	0.029	0.016	8.2E-03	4.4E-03	1.3E-04
PM_{10}	1500	1000	390	220	110	60	1.8
Surface Water - Generic Reservoir (mg/L) [b]							
Arsenic	3.0E-05	2.1E-05	7.8E-06	4.5E-06	2.2E-06	1.2E-06	3.7E-08
Cadmium	1.5E-04	1.0E-04	3.9E-05	2.2E-05	1.1E-05	6.0E-06	1.8E-07
Chromium	1.8E-04	1.2E-04	4.7E-05	2.7E-05	1.3E-05	7.2E-06	2.2E-07
Cobalt	1.5E-05	1.0E-05	3.9E-06	2.2E-06	1.1E-06	6.0E-07	1.8E-08
Manganese	4.5E-05	3.1E-05	1.2E-05	6.7E-06	3.3E-06	1.8E-06	5.5E-08
Mercury	3.0E-05	2.1E-05	7.8E-06	4.5E-06	2.2E-06	1.2E-06	3.7E-08
Nickel	2.7E-04	1.9E-04	7.0E-05	4.0E-05	2.0E-05	1.1E-05	3.3E-07
PM_{10}	3.72	2.55	0.96	0.55	0.27	0.15	0.00
Surface Water - Generic River (mg/L) [c]							
Arsenic	3.0E-04	2.1E-04	7.8E-05	4.5E-05	2.2E-06	1.2E-05	3.7E-07
Cadmium	1.5E-03	1.0E-03	3.9E-04	2.2E-04	1.1E-05	6.0E-05	1.8E-06
Chromium	1.8E-03	1.2E-03	4.7E-04	2.7E-04	1.3E-05	7.2E-05	2.2E-06
Cobalt	1.5E-04	1.0E-04	3.9E-05	2.2E-05	1.1E-06	6.0E-06	1.8E-07
Manganese	4.5E-04	3.1E-04	1.2E-04	6.7E-05	3.3E-06	1.8E-05	5.5E-07
Mercury	3.0E-04	2.1E-04	7.8E-05	4.5E-05	2.2E-06	1.2E-05	3.7E-07
Nickel	2.7E-03	1.9E-03	7.0E-04	4.0E-04	2.0E-05	1.1E-04	3.3E-06
PM_{10}	37.2	25.5	9.6	5.5	2.7	1.5	0.045

Notes:

[a] HAP and PM_{10} concentrations are calculated based on the entire air modeling domain with no abiotic or biotic loss of metals from wet and dry deposition. A 1-cm mixing depth and a soil density of 1.5 g/cm^3 were assumed (USEPA, 1998b).

[b] HAP and PM_{10} concentrations are calculated over a generic reservoir receiving the maximum wet and dry deposition of the entire modeling domain with no abiotic or biotic loss of metals from total and wet deposition. A 20-foot mixing depth and a water density of 1.0 g/cm^3 were assumed.

[c] HAP and PM_{10} concentrations are calculated over a generic river receiving the maximum wet and dry deposition of the entire modeling domain with no abiotic or biotic loss of metals from total and wet deposition. A 2-foot mixing depth and a water density of 1.0 g/cm^3 were assumed.

TABLE 3

Calculation of Maximum Soil Concentration from Wastewater Application to 31 Acres During the 30-Year Life of the Energy Facility

Screening-Level Ecological Risk Assessment

COB Energy Facility, Klamath County, Oregon

Parameter/Analyte		(From Aquifer) Raw Water Max Value	Units	Laboratory MRL [a]	Units		RO Reject (75% Recovery) Max Value	Units	Ratio Raw/Reject	RO Reject Estimated from Nondetects	Units	Wastewater Values for ERA [b]	Units	Maximum Estimated Soil Concentration [c] (mg/kg)
Flow Rate		208	gpm	--	--		49	gpm				49		
Inorganics														
Aluminum				100	ug/L					0.1954	mg/L	0.1954	mg/L	9.65
Ammonia as N				0.1	mg/L	<	0.00	mg/L		0.1954	mg/L	0.1954	mg/L	9.65
Antimony				2	ug/L					0.00391	mg/L	0.00391	mg/L	0.193
Arsenic				2	ug/L					0.00391	mg/L	0.00391	mg/L	0.193
Barium				25	ug/L					0.04885	mg/L	0.04885	mg/L	2.413
Beryllium				4	ug/L					0.00782	mg/L	0.00782	mg/L	0.386
Boron	<	0.275	mg/L	275	ug/L	<	0.54	mg/L	1.964			0.540	mg/L	26.68
Cadmium				0.5	ug/L					0.00098	mg/L	0.00098	mg/L	0.048
Calcium		14.8	mg/L	500	ug/L	<	28.92	mg/L	1.954			28.920	mg/L	1429
Chloride		2.12	mg/L	0.1	mg/L	<	4.14	mg/L	1.953			4.140	mg/L	204.5
Chromium III				1	ug/L					0.00195	mg/L	0.00195	mg/L	0.097
Chromium VI				2	ug/L					0.00391	mg/L	0.00391	mg/L	0.193
Cobalt				10	ug/L					0.01954	mg/L	0.01954	mg/L	0.965
Copper				10	ug/L	<	0.00	mg/L		0.01954	mg/L	0.01954	mg/L	0.965
Fluoride	<	0.1	mg/L	0.1	mg/L	<	0.20	mg/L	2.000			0.200	mg/L	9.88
Iron		0.0736	mg/L	100	ug/L	<	0.14	mg/L	1.902			0.140	mg/L	6.92
Lead				3	ug/L					0.00586	mg/L	0.00586	mg/L	0.290
Magnesium		6.01	mg/L	500	ug/L	<	11.74	mg/L	1.953			11.740	mg/L	580
Manganese	<	0.01	mg/L	10	ug/L	<	0.02	mg/L	2.000			0.020	mg/L	0.988
Mercury				0.1	ug/L					0.00020	mg/L	0.00020	mg/L	0.010
Molybdenum				25	ug/L					0.04885	mg/L	0.04885	mg/L	2.413
Nickel				20	ug/L					0.03908	mg/L	0.03908	mg/L	1.931
Nitrate as N		0.43	mg/L	0.01	mg/L	<	0.84	mg/L	1.953			0.840	mg/L	41.5
Nitrite as N	<	0.01	mg/L	0.01	mg/L	<	0.02	mg/L	2.000			0.020	mg/L	0.988
Phosphorous				0.05	mg/L	<	0.05	mg/L				0.050	mg/L	2.470
Potassium		2.16	mg/L	100	ug/L	<	4.22	mg/L	1.954			4.220	mg/L	208.5
Selenium				2	ug/L					0.00391	mg/L	0.00391	mg/L	0.193
Silver				0.5	ug/L					0.00098	mg/L	0.00098	mg/L	0.048
Sodium		10.3	mg/L	1000	ug/L	<	20.12	mg/L	1.953			20.120	mg/L	994
Strontium				100	ug/L					0.1954	mg/L	0.1954	mg/L	9.65
Sulfate		3.22	mg/L	0.1	mg/L		6.29	mg/L	1.953			6.290	mg/L	310.7
Sulfide				1	mg S^2/L					1.954	mg/L	1.954	mg/L	96.5
Sulfite				2	mg/L	<	1.00	mg/L		3.908	mg/L	1.00	mg/L	49.4
Thallium				2	ug/L					0.00391	mg/L	0.00391	mg/L	0.193
Tin				25	ug/L					0.04885	mg/L	0.04885	mg/L	2.413
Titanium				100	ug/L					0.1954	mg/L	0.1954	mg/L	9.65
Zinc				20	ug/L					0.03908	mg/L	0.03908	mg/L	1.931
Organics														
Cyanide, total				0.01	mg/L					0.01954	mg/L	0.01954	mg/L	0.965
Oil & Grease				5	mg/L	<	0.30	mg/L		9.77	mg/L	0.300	mg/L	14.82
Orthophosphate as P				0.01	mg/L	<	0.05	mg/L		0.01954	mg/L	0.05	mg/L	2.470
Phenol				0.005	mg/L					0.00977	mg/L	0.00977	mg/L	0.483
TDS		104	mg/L	5	mg/L	0	203	mg/L	1.952			203	mg/L	10028
TSS				2	mg/L	<	1.00	mg/L		3.908	mg/L	1	mg/L	49.4
Water Properties														
pH		8.4	std Units	--	--		7.5-9	std Units		--		7.5-9	std Units	--
Silica		36.4	mg/L	0.4	mg/L	<	71.120	mg/L	1.954			71.12	mg/L	9222

TABLE 3

Calculation of Maximum Soil Concentration from Wastewater Application to 31 Acres During the 30-Year Life of the Energy Facility

Screening-Level Ecological Risk Assessment

COB Energy Facility, Klamath County, Oregon

Parameter/Analyte	(From Aquifer) Raw Water Max Value	Units	Laboratory MRL [a]	Units		RO Reject (75% Recovery) Max Value	Units	Ratio Raw/Reject	RO Reject Estimated from Nondetects	Units	Wastewater Values for ERA [b]	Units	Maximum Estimated Soil Concentration [c] (mg/kg)
Total Alkalinity	84	mg/L as $CaCO_3$	5	mg/L as $CaCO_3$		164.120	mg/L as $CaCO_3$	1.954			164.12	mg/L as $CaCO_3$	21280
Total Organic Content (TOC)			0.5	mg/L	<	1.50	mg/L		0.977	mg/L	1.500	mg/L	194.5

Notes:

[a] Laboratory MRL = the method reporting limit provided by the analytical laboratory.

[b] Wastewater values used for the Ecological Risk Assessment (ERA) assume that nondetected constituents are present at some concentration below the detection limit. For these constituents, the method reporting limit was multiplied by 1.954 (raw/reject ratio for all other detected metals) to obtain the wastewater value for the ERA.

[c] The maximum soil concentration (MSC) (mg constituent/kg soil) was calculated using the following equation: MSC = (PWC * AWP * L)/(AA * MD * BD), where PWC = predicted wastewater values (mg/L); AWP = annual wastewater production (24.3 million gallons or 91,985,506 L); L = life span of the energy plant (30 years); AA = application area (46 acres or 186,200 m^2); MD = mixing depth for tilled agricultural land (20 cm or 0.2 m); and BD = literature-based bulk density of soil (1500 kg/m^3). This calculation assumes that all constituents accumulate during the 30 years and that nothing is lost to biodegradation, erosion, leaching, or other biotic or abiotic loss mechanisms.

TABLE 4

Assessment Endpoints and Measures of Exposure and Effects

Screening-Level Ecological Risk Assessment

COB Energy Facility, Klamath County, Oregon

Assessment Endpoints					
Entity	**Attribute**	**Effect Level**	**Receptor**	**Measures of Exposure**	**Measures of Effects**
Aquatic Organisms *	Growth, reproduction or survival	Reduction of attribute	NA	Estimated concentrations of COPECs in water.	Comparison of maximum estimated water concentrations to benchmark values for toxic effects that could affect growth, reproduction, or survival
Plants	Growth, reproduction or survival	20% reduction of attribute	NA	Estimated concentrations of COPECs in soil.	Comparison of maximum estimated soil concentrations to benchmark values for toxic effects that could affect growth, reproduction, or survival.
Soil Invertebrates	Growth, reproduction or survival	20% reduction of attribute	NA	Estimated concentrations of COPECs in soil.	Comparison of maximum estimated soil concentrations to benchmark values for toxic effects that could affect growth, reproduction, or survival.
Birds	Growth, reproduction or survival	20% reduction of attribute	Western Meadowlark	Estimated concentrations of COPECs in soil.	Comparison of exposure estimates (based on maximum estimated soil concentrations) to literature-derived benchmark values.
	Individual health and survival	No acceptable effect	Bald Eagle	Estimated concentrations of COPECs in water.	Comparison of exposure estimates (based on maximum estimated water concentrations) to literature-derived benchmark values.
Mammals	Growth, reproduction or survival	20% reduction of attribute	Deer Mouse	Estimated concentrations of COPECs in soil.	Comparison of exposure estimates (based on maximum estimated soil concentrations) to literature-derived benchmark values.

Note:

* Includes fish such as the shortnose sucker and the Lost River sucker.

COPEC = chemicals of potential ecological concern

NA = not available

TABLE 5

Exposure Parameters for Wildlife Receptors

Screening-Level Ecological Risk Assessment

COB Energy Facility, Klamath County, Oregon

Exposure Factors

Species	Body Weight: Mean (kg)	Body Weight: Notes	Body Weight: Reference	Ingestion rate - dry wt. (kg/kg BW/d)	Ingestion rate - dry wt.: Notes	Ingestion rate - dry wt.: Reference	Ingestion rate - water (L/kg BW/d)	Ingestion rate - water: Notes	Ingestion rate - water: Reference
Birds									
Western Meadowlark *Sturnella neglecta*	Mean: **0.110**	Data for Colorado	Wiens and Innis 1974	**0.04**	Daily food consumption for western meadowlarks estimated at 3 times the stomach capacity (3.9 g). Ingestion rate based on body weight of 0.110 kg.	Sample et al. 1997	**0.12**	Based on a minimum water consumption for weight maintenance of 66% of the ad libitum rate and a body weight of 0.1115 kg.	Sample et al. 1997
Bald Eagle Haliaeetus leucocephalus	Male: 4.014 Female: 5.089 Both: **4.552** Range: 3.524 - 5.756	Data for Alaska	Imler and Kalmbach 1955	**0.0163**	Average ingestion rate based on diet of chum salmon at temperatures of -10, 5, and 20° C (14, 41, and 68° F).	Stalmaster and Gessaman 1984	**0.036**	Estimated using allometric equation for birds and a body weight of 4.552 kg.	Calder and Braun 1983
Mammals									
Deer Mouse *Peromyscus maniculatus*	Male: 0.026 **Female: 0.023**	Means for values reported for California	Silva and Downing 1995	**0.45**	Maximum value reported. Represents lactating female.	EPA 1993	0.14	Estimated using allometric equation for mammals and a body weight of 0.026 kg.	Calder and Braun 1983

Feeding Habits and Foraging Range

Species	Biotic Dietary Items (% Diet): Plants	Terrestrial Invertebrates	Mammals and Birds	Fish	Notes	Major food items	Reference	Abiotic Media Ingestion (% diet): Soil	Notes	Reference	Foraging Range: Hectares	other (miles, km)	Reference	Notes
Birds														
Western Meadowlark *Sturnella neglecta*	**36.7**	**63.3**			Data for North America.	Western meadowlarks are ground foragers that consume both plant material (primarily seeds) and invertebrates.	Lanyon 1994	**2.08**	Data not available for western meadowlarks. Assumed to be similar to value derived for the American robin.	Sample et al. 1997	5.04		Lanyon 1994, Kendeigh 1941, and Schaef and Picman 1988	Median from 3 studies.
Bald Eagle Haliaeetus leucocephalus			24	66		Opportunistic feeder, primarily fish, waterfowl, and other animals. For this assessment assumed diet of **100 percent fish**.	Ofelt 1975	**0**	Data not available for bald eagle. Assumed to be negligible due to foraging behavior.			radius = 0.64 km	Mahaffy and Frenzel 1987	
Mammals														
Deer Mouse *Peromyscus maniculatus*	**50**	**50**			Approximate diet of mice in Colorado over all seasons.	Seeds and terrestrial invertebrates, mainly insects.	EPA 1993	**2**	assumed comparable to white-footed mouse	adapted from Beyer et al. 1994	0.1 - 0.2		Brylski 1990	

Note:

Bold values were used for the exposure calculations.

TABLE 6

Bioaccumulation Values and Models for Plants, Soil Invertebrates, and Aquatic Organisms for Calculation of Wildlife Exposure

Screening-Level Ecological Risk Assessment

COB Energy Facility, Klamath County, Oregon

			Regression Model					
Analytes	**N**	**BAF**	**Slope (B1)**	**Intercept (B0)**	**Form**	**Transfer Type**	**Comments**	**Reference**
Plants								
Antimony	17	0.1487				soil-plant	90^{th} percentile value	CH2M HILL, 2002
Arsenic		--	0.564	-1.992	Len(plant) = B0+B1(Len[soil])	soil-plant	represents bioaccumulation into aboveground plant	Bechtel-Jacobs, 1998
Beryllium		--						
Cadmium		--	0.546	-0.476	Len(plant) = B0+B1(Len[soil])	soil-plant	represents bioaccumulation into aboveground plant	Bechtel-Jacobs, 1998
Chromium	28	0.041				soil-plant	median of 28 values	Bechtel-Jacobs, 1998
Cobalt	28	0.0075					median of 28 values	Bechtel-Jacobs, 1998
Cyanide		***1***					assumed value	
Iron	27	1				soil-seed	90^{th} percentile value; seeds surrogate for plants	CH2M HILL, 2002
Magnesium	8	7.333					mean value (90^{th} Percentile highly skewed)	CH2M HILL, 2002
Manganese	28	0.0792					median of 28 values	Bechtel-Jacobs, 1998
Mercury		--	0.544	-0.996	Len(plant) = B0+B1(Len[soil])	soil-plant	represents bioaccumulation into aboveground plant	Bechtel-Jacobs, 1998
Nickel		--	0.748	-2.224	Len(plant) = B0+B1(Len[soil])	soil-plant	represents bioaccumulation into aboveground plant	Bechtel-Jacobs, 1998
Phenol		5.5963			$BAF=10^{\wedge 1.31-0.385(log10Kow)}$	soil-plant	calculated with log Cow of 1.46 using model from USEPA 2000	
Silver		***1***					assumed value	
Thallium		***1***					assumed value	
Tin		***1***					assumed value	
Arthropods								
Antimony	6	0.025				soil-insect	90^{th} percentile value	CH2M HILL, 2002
Arsenic	44	0.1258				soil-insect	90^{th} percentile value	CH2M HILL, 2002
Beryllium	24	0.0286				soil-insect	90^{th} percentile value	CH2M HILL, 2002
Cadmium	210	4.078				soil-insect	90^{th} percentile value	CH2M HILL, 2002
Chromium	28	0.546				soil-insect	90^{th} percentile value	CH2M HILL, 2002
Cobalt	24	0.023				soil-insect	90^{th} percentile value	CH2M HILL, 2002
Cyanide		***1***					assumed value	
Magnesium	26	1.5047				soil-insect	90^{th} percentile value	CH2M HILL, 2002
Manganese	26	0.2267				soil-insect	90^{th} percentile value	CH2M HILL, 2002
Mercury	24	2				soil-insect	90^{th} percentile value	CH2M HILL, 2002
Nickel	28	0.5118				soil-insect	90^{th} percentile value	CH2M HILL, 2002
Phenol		26.58			$BAF=10^{\wedge (logKow-0.6)/(foc*10^{\wedge}(0.983*logKow+0.00028))}$	soil-earthworm	calculated with log Cow of 1.46 using model from Sample et al. 1997; foci assumed to be 0.01	
Silver	22	0.12				soil-insect	90^{th} percentile value	CH2M HILL, 2002
Thallium	18	0.256				soil-insect	90^{th} percentile value	CH2M HILL, 2002
Tin		***1***					assumed value	
Aquatic Organisms								
Arsenic		17	--	--	--	water-fish	BCF, trophic level 3 and 4 BAF	Sample et al, 1997
Cadmium		12400	--	--	--	water-fish	BCF, trophic level 3 and 4 BAF	Sample et al, 1997
Chromium		3	--	--	--	water-fish	Based on Chromium 6+	Sample et al, 1997
Cobalt		--	--	--	--			
Manganese		--	--	--	--			
Mercury		27900	--	--	--	water-fish	Trophic level 3 BAF	Sample et al, 1997
Nickel		106	--	--	--	water-fish	BCF, trophic level 3 and 4 BAF	Sample et al, 1997

Note:

All biological accumulation factors (BAFs) were assumed to be in dry weight.

TABLE 7

Screening-Level Benchmark Values for Soil and Water

Screening-Level Ecological Risk Assessment

COB Energy Facility, Klamath County, Oregon

	Oregon ODEQ Soil Screening Level Values (mg/kg) [a]				Oregon ODEQ Aquatic Screening Level Values (mg/L) [b]	
Analyte	**Plants**	**Invertebrates**	**Birds**	**Mammals**	**Aquatic Biota**	**Birds**
Inorganics						
Aluminum	50	600	450	107		
Antimony	5	--	--	15		
Arsenic	10	60	10	29	0.15	18
Barium	500	3000	85	638		
Beryllium	10	--	--	83		
Boron	0.5	20	120	3500		
Cadmium	4	20	6	125	0.0022	10
Chromium III	1	0.4	4	340000	0.011	7.2
Chromium VI	--	--	--	410		
Cobalt	20	1000		150	0.023	--
Copper	100	50	190	390		
Fluoride	200	30	32	2285		
Iron	10	200		--		
Lead	50	500	16	4000		
Manganese	500	100	4125	11000	0.12	7242
Mercury	0.3	0.1	1.5	73	0.00077	3.3
Molybdenum	2	200	15	14		
Nickel	30	200	320	625	0.052	562
Selenium	1	70	2	25		
Silver	2	50	--	--		
Strontium	--	--	--	32875		
Thallium	1	--	--	1		
Tin	50	2000	--	--		
Titanium	--	1000	--	--		
Zinc	50	200	60	20000		
Organics						
Phenol	70	30	--	--		

Notes:

[a] Screening values from the Oregon Department of Environmental Quality (ODEQ) *Guidance for Ecological Risk Assessment: Level II Screening Level Values* (ODEQ, 2001).

[b] Screening values from the ODEQ *Guidance for Ecological Risk Assessment: Level II Screening Level Values* (ODEQ, 2001). Only values required for screening of air emissions deposition in surface water presented. Wastewater application will not impact surface water.

-- not available

TABLE 8

Summary of Wildlife Toxicity Data for Analytes Lacking Oregon Department of Environmental Quality (ODEQ) Screening-Level Values or Requiring Further Evaluation

Screening-Level Ecological Risk Assessment

COB Energy Facility, Klamath County, Oregon

Analyte	Analyte/surrogate	Study	Test species	Body Weight (kg)	Endpoint	Endpoint 2	Duration	NOAEL (mg/kg/d)	LOAEL (mg/kg/d)	Notes
Birds										
Arsenic	Sodium arsenate	Stanley et al. 1994	mallard duck	1	reproduction	ducklings/successful nest	4 wks prior to pairing through 14 d post hatch (chronic)	9.3	40.3	CH2M HILL 2000 (ALT BTAG)
Arsenic	Sodium arsenate	Stanley et al., 1994	mallard duck	1	reproduction	ducklings/successful nest	4 wks prior to pairing through 14 d post hatch (chronic)	5.5	22.01	EFA West 1998 (BTAG)
Arsenic	Sodium arsenite	USFWS 1964	mallard duck	1	mortality	mortality	128 d (chronic)	5.14	12.84	
Cadmium	Cadmium Chloride	Cain et al., 1983	mallard duck	0.8	hematology	hematological effects	12 wks (chronic)	0.08	NA	EFA West 1998 (BTAG)
Cadmium	Cadmium Chloride	Richardson et al., 1974	Japanese quail	0.084	growth	body weight	6 wks (chronic)	NA	10.43	EFA West 1998 (BTAG)
Cadmium	Cadmium Chloride	White and Finley 1978	mallard duck	1.153	reproduction	eggs/hen	90 d (critical life-stage = chronic)	1.45	20.03	CH2M HILL 2000 (ALT BTAG)
Chromium	$CrK(SO_4)^2$	Haseltine et al., 1985	black duck	1.25	reproduction	duckling survival	10 mo (chronic)	1	5	
Cobalt		Diaz et al., 1994	broiler chicken	0.45	growth	weight	14 d (critical life-stage = chronic)	12.36	24.72	assumed BW for 120 day-old chicken
Iron		NRC 1980 in McDowell 1992	white leghorn chicken	1.5	NA	maximum tolerable level	chronic	70.5	NA	
Manganese	Manganese Oxide	Laskey and Edens 1985	Japanese quail	0.072	growth	growth	75 d (chronic)	977	NA	CH2M HILL 2000 (ALT BTAG)
Manganese	Manganese Oxide	Laskey and Edens 1985	Japanese quail	0.072	behavior	aggressive behavior	75 d (chronic)	98	977	
Manganese	Manganese oxide	Laskey and Edens, 1985	Japanese quail	0.072	growth, behavior	weight gain, aggressive behavior	75 d (chronic)	77.6	776	EFA West 1998 (BTAG)
Mercury	MeHg Dicyandiamide	USEPA, 1995	mallard duck	1	reproduction	number eggs and ducklings	3 gen (chronic)	0.039	0.18	EFA West 1998 (BTAG)
Mercury	MeHgCl	Heinz, 1976; Heinz and Hoffman, 1998	mallard duck	1	reproduction	duckling 7 day survival	2.5 mo - 2 gen (chronic)	0.068	0.37	CH2M HILL 2000 (ALT BTAG)
Nickel	Nickel sulfate	Cain and Pafford 1981	mallard	0.782	physiological	tremors, joint edema	90 d (chronic)	17.6	77.4	CH2M HILL 2000 (ALT BTAG)
Nickel	Nickel sulfate	Cain and Pafford, 1981	mallard	0.58	physiological	tremors, joint edema	90 d (chronic)	1.38	55.3	EFA West 1998 (BTAG)
Nickel	Nickel sulfate	Weber and Reid 1968	chicks	0.45	growth	growth	4 wks (chronic)	25.3	42.2	
Silver		USEPA 1997	mallard duck	1	NR	NA	14 days (acute)	17.8	NA	multiplied acute value (1780) by 0.01
Thallium		Schafer 1972	starling	0.82	survivorship	% survival	acute	0.053	NA	multiplied acute value (5.3) by 0.01
Tin	bis (Tributyltin) oxide (TBTO)	Schlatterer et al. 1993	Japanese quail	0.15	reproduction	reduced egg hatchability	6 wks (chronic)	6.8	16.9	
Mammals										
Iron		Sobotka et al., 1996	rat	0.35		subchronic NOAEL	subchronic	2.8	NA	multiplied subchronic value (28) by 0.1
Silver	AgNO3	Rungby and Dascher 1984	mouse	0.03	behavior	activity	125 d (chronic)	2.38	23.8	
Tin	bis (Tributyltin) oxide (TBTO)	Davis et al. 1987	mouse	0.03	reproduction	reduced fetal weight and survival	d 6-15 of gestation (chronic)	23.4	35	
Cyanide	Potassium cyanide	Tewe and Maner 1981	rat	0.35	reproduction	fetal growth	gestation and lactation (chronic)	68.7	NA	
Phenol		Bishop et al. 1997	Mouse	0.03	reproduction, body weight	reproduction, weight gain	6 mo (chronic)	17.1	NA	

Note:

Highlighted studies used in risk evaluation.

TABLE 9

Receptor-Specific NOAELs and LOAELs Estimated from Literature-Derived Data Using Allometric Scaling Methods Presented in Sample et al. (1996) and Sample and Arenal (1999)[a].

Screening-Level Ecological Risk Assessment

COB Energy Facility, Klamath County, Oregon

Receptor	Analyte	Study	Test species	Test Body Weight (kg)	Test NOAEL (mg/kg/d)	Test LOAEL[b] (mg/kg/d)	Scaling Factor	Receptor Body Weight (kg)	Receptor NOAEL	Receptor LOAEL[b]
Birds										
Western	Arsenic	Stanley et al. 1994	mallard duck	1	9.3	40.3	1.2	0.11	5.98	25.92
Meadowlark	Cadmium	White and Finley 1978	mallard duck	1.153	1.45	20.03	1.2	0.11	0.91	12.52
	Chromium III	Haseltine et., al., 1985	black duck	1.25	1	5	1.2	0.11	0.62	3.08
	Cobalt	Diaz et al., 1994	broiler chicken	0.45	12.36	24.72	1.2	0.11	9.33	18.65
	Iron	NRC 1980 in McDowell 1992	white leghorn chicken	1.5	70.5	NA	1.2	0.11	41.81	NA
	Manganese	Laskey and Edens 1985	Japanese quail	0.072	977	NA	1.2	0.11	1063.42	NA
	Mercury	Heinz, 1976; Heinz and Hoffman, 1998	mallard duck	1	0.068	0.37	1.2	0.11	0.04	0.24
	Nickel	Cain and Pafford 1981	mallard	0.782	17.6	77.4	1.2	0.11	11.89	52.29
	Silver	USEPA 1997	mallard duck	1	17.8	NA	1.2	0.11	11.45	NA
	Thallium	Schafer 1972	starling	0.82	0.053	NA	1.2	0.11	0.04	NA
	Tin	Schlatterer et al. 1993	Japanese quail	0.15	6.8	16.9	1.2	0.11	6.39	15.88
Mammals										
Deer Mouse	Iron	Sobotka et al., 1996	rat	0.35	2.8	NA	0.94	0.023	3.30	NA
	Silver	Rungby and Dascher 1984	mouse	0.03	2.38	23.8	0.94	0.023	2.42	24.18
	Tin	Davis et al. 1987	mouse	0.03	23.4	35	0.94	0.023	23.78	35.56
	Cyanide, total	Tewe and Maner 1981	rat	0.273	68.7	NA	0.94	0.023	79.69	NA
	Phenol	Bishop et al. 1997	Mouse	0.03	17.1	NA	0.94	0.023	17.37	NA

[a] Calculations are based on toxicity values and body weights for test species from Table 8 and body weights for receptors from Table 5. Scaling factors of 0.94 and 1.2 were applied for mammals and birds, respectively (Sample and Arenal, 1999). Allometric equation is in the form of $NOAEL_{receptor} = NOAEL_{test} (BW_{test}/BW_{receptor})^{(1\text{-scaling factor})}$.

[b] NA = Toxicity values for this analyte were not available.

References:

Bishop, J.B., R.W. Morris, J.C. Seely, L.A. Hughs, K.T. Kain, and W.M. Generoso. 1997. Alterations in the reproductive patterns of female mice exposed to xenobiotics."*Fundamental and Applied Toxicology* 40: 191-204.

Davis, A., R. Barale, G. Brun, et al. 1987. Evaluation of the genetic and embryotoxic effects of bis(tri-n-butyltin)oxide (TBTO), a broad-spectrum pesticide, in multiple in vivo and in vitro short-term tests *Muta. Res.* 188: 65-95.

Rungby, J., and G. Danscher. 1984. Hypoactivity in silver exposed mice. *Acta Pharmacol. Et. Toxicol.* 55:398-401.

Sobotka TJ, Whittaker P, Sobotka JM, Brodie RE, Quander DY, Robl M, Bryant M, Barton CN. 1996. Neurobehavioral dysfunctions associated with dietary iron overload. Physiol Behav. Feb. 59(2):213-9.

Tewe, O.O., and J.H. Maner. 1981. Long-term and carry-over effect of dietary inorganic cyanide (KCN) in the life cycle performance and metabolism of rats. *Toxicol. Appl. Pharmacol.* 58:1-7.

TABLE 10

Comparison of Oregon Department of Environmental Quality (ODEQ) Soil Screening Level Values to Estimated Soil Concentrations (Incremental, Background, and Total) From Air Emissions Deposition

Screening-Level Ecological Risk Assessment

COB Energy Facility, Klamath County, Oregon

	Maximum		Total (Incremental	Oregon Screening Level Values [b]				Hazard Quotients - Incremental [c]				Hazard Quotients - Background [c]				Hazard Quotients - Total [c]			
	Incremental	Background	+ Background)		Soil				Soil				Soil				Soil		
Analyte	(mg/kg)	(mg/kg) [a]	(mg/kg)	Plant	Invertebrate	Bird	Mammal	Plant	Invertebrate	Bird	Mammal	Plant	Invertebrate	Bird	Mammal	Plant	Invertebrate	Bird	Mammal
Arsenic	0.193	4.1	4.11	10	60	10	29	0.019	0.003	0.019	0.007	0.410	0.068	0.410	0.141	0.411	0.069	0.411	0.142
Cadmium	0.048	***1***	1.06	4	20	6	125	0.012	0.002	0.008	0.000	0.250	0.050	0.167	0.008	0.265	0.053	0.177	0.008
Chromium	0.097	45	45.07	1	0.4	4	340000	0.097	0.241	0.024	0.000	45.000	112.500	11.250	0.000	45.074	112.684	11.268	0.000
Cobalt	0.965	15	15.01	20	1000	--	150	0.048	0.001		0.006	0.750	0.015		0.100	0.750	0.015		0.100
Manganese	0.988	600	600.02	500	100	4125	1100	0.002	0.010	0.000	0.001	1.200	6.000	0.145	0.545	1.200	6.000	0.145	0.545
Mercury	0.010	0.06	0.07	0.3	0.1	1.5	73	0.032	0.097	0.006	0.000	0.200	0.600	0.040	0.001	0.241	0.723	0.048	0.001
Nickel	1.931	32.5	32.61	30	200	320	625	0.064	0.010	0.006	0.003	1.083	0.163	0.102	0.052	1.087	0.163	0.102	0.052

Notes:

[a] Background values are the mean of Klamath County background concentrations reported by USGS (Boerngen, J. G. and H. T. Shacklette, 1981. Chemical Analyses of Soils and Other Surficial Materials of the Conterminous United States. U.S. Geological Survey, Open-File Report 81-197.). Italicized and bold values are Washington Statewide Background levels (San Jaun, C. 1994. Natural Background Soil Metals Concentrations in Washington State. Toxics Cleanup Program, Washington State Department of Ecology. Publication # 94-115, October.) and were used when Klamath County values were not available.

[b] Screening values from the Oregon Department of Environmental Quality (Guidance for Ecological Risk Assessment: Level II Screening Level Values, December 2001).

[c] Hazard Quotient (HQ) = soil concentration (Incremental, Background, or Total)/Oregon screening level value. Incremental HQs represent risk estimate from wastewater only; background HQs represent risk estimate from background levels; and total HQs represent the combined incremental and background risk.

-- Not available

Highlighted values represent exceedance of the screening levels.

TABLE 11

Exposure and Hazard Quotient (HQ) Calculations for Air Emissions Constituents Lacking Oregon Department of Environmental Quality (ODEQ) Screening Values for Birds or for Analytes that Exceed ODEQ Screening Values and for Bald Eagles. [a]

Screening-Level Ecological Risk Assessment

COB Energy Facility, Klamath County, Oregon

			Bioaccumulation Values									Exposure Estimates [e]						Literature Benchmarks			
	Maximum Soil	Maximum Water	Plants [b]			Invertebrates [c]			Fish [d]												
	Concentration	Concentration		Regression Model			Regression Model													NOAEL	LOAEL
Analytes	(mg/kg)	(mg/L)	BAF	B1	B0	BAF	B1	B0	BCF	B1	B0	Plant	Invert	Fish	Soil	Water	Total	NOAEL	LOAEL	HQ	HQ
Western Meadowlark																					
Incremental																					
Chromium	0.290	0.000181	0.041			0.306			3	0.7338	-1.4599	0.0002	0.0022	0.0000	0.0002	0.0000	0.0027	0.615	3.075	0.004	0.001
Cobalt	0.965	0.000015	0.0075			0.122			--			0.0016	0.0265	NA	0.0087	0.0000	0.0368	1.413	14.129	0.026	0.003
Background																					
Chromium	45	0.000181	0.041			0.306			3	0.7338	-1.4599	0.0273	0.3470	0.0000	0.0374	0.0000	0.4118	0.615	3.075	0.670	0.134
Cobalt	15	0.000015	0.0075			0.122			1			0.0017	0.0461	NA	0.0125	0.0000	0.0603	9.325	18.650	0.006	0.003
Total																					
Chromium	45.290	0.000181	0.041			0.306			3	0.7338	-1.4599	0.0275	0.3492	0.0000	0.0377	0.0000	0.4144	0.615	3.075	0.674	0.135
Cobalt	15.965	0.000015	0.0075			0.122			1			0.0018	0.0491	NA	0.0133	0.0000	0.0641	9.325	18.650	0.007	0.003
Bald Eagle																					
Arsenic	0.012	0.000030		0.564	-1.992		0.706	-1.421	17			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	12.593	54.569	0.000	0.000
Cadmium	0.061	0.000151		0.546	-0.476		0.795	2.114	12400			0.0000	0.0000	0.0306	0.0000	0.0000	0.0306	1.908	26.361	0.016	0.001
Chromium	0.074	0.000181	0.041			0.306			3	0.7338	-1.4599	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.295	6.475	0.000	0.000
Cobalt	0.006	0.000015	0.0075			0.122			1			0.0000	0.0000	NA	0.0000	0.0000	0.0000	19.634	39.269	0.000	0.000
Manganese	0.018	0.000045	0.0792				0.682	-0.809	1			0.0000	0.0000	NA	0.0000	0.0000	0.0000	2239.074	NA	0.000	NA
Mercury	0.012	0.000030		0.544	-0.996		0.118	-0.684	27900			0.0000	0.0000	0.0138	0.0000	0.0000	0.0138	0.092	0.501	0.149	0.027
Nickel	0.111	0.000272		0.748	-2.224	1.059			106	0.4658	-0.2462	0.0000	0.0000	0.0005	0.0000	0.0000	0.0005	25.033	110.088	0.000	0.000

Notes:

[a] Because bald eagles utilizing the McFall Reservoir are of concern, the maximum values for the generic reservoir (i.e., 20-ft mixing depth) were used in the exposure calculation

[b] Bioaccumulation values for plants from CH2M HILL (2002).

[c] Bioaccumulation values for invertebrates (arthropods) from CH2M HILL (2002).

[d] Bioaccumulation values for fish from Sample et al. 1997 for all analytes, except cobalt and manganese. No bioaccumulation values were available for these analytes; therefore a value of 1 was assumed.

[e] Exposure estimates calculated using the life-history parameters presented in Table 5.

NA = not available

TABLE 12

Comparison of Aquatic Screening Values to Maximum Estimated Surface Water Concentrations (Generic Reservoir and Generic River) From Air Emissions Deposition

Screening-Level Ecological Risk Assessment

COB Energy Facility, Klamath County, Oregon

Analyte	Maximum Concentration (mg/L)	Oregon DEQ Screening Level Values [a]		Hazard Quotients [b]	
		Aquatic Biota	Birds	Aquatic Biota	Birds
Generic Reservoir (20-ft mixing depth)					
Arsenic	0.0000302	0.15	18	0.000	0.000
Cadmium	0.0001512	0.0022	10	0.069	0.000
Chromium	0.0001814	0.011	7.2	0.016	0.000
Cobalt	0.0000151	0.023	--	0.001	
Manganese	0.0000454	0.12	7242	0.000	0.000
Mercury	0.0000302	0.00077	3.3	0.039	0.000
Nickel	0.0002721	0.052	562	0.005	0.000
Generic River (2-ft mixing depth)					
Arsenic	3.0E-04	0.15	18	0.002	0.000
Cadmium	1.5E-03	0.0022	10	0.687	0.000
Chromium	1.8E-03	0.011	7.2	0.165	0.000
Cobalt	1.5E-04	0.023	--	0.007	
Manganese	4.5E-04	0.12	7242	0.004	0.000
Mercury	3.0E-04	0.00077	3.3	0.393	0.000
Nickel	2.7E-03	0.052	562	0.052	0.000

Notes:

[a] Screening values from the Oregon Department of Environmental Quality (ODEQ) (Guidance for Ecological Risk Assessment: Level II Screening Level Values, December 2001).

[b] Hazard Quotient (HQ) = maximum water concentration/ODEQ or NAWQC values.

-- Not available

Highlighted values represent exceedance of the screening levels.

TABLE 13

Comparison of Oregon Department of Environmental Quality (DEQ) Soil Screening Level Values to Estimated Soil Concentrations (Incremental, Background, and Total) Assuming a 20-cm Mixing Depth for Tilled Agricultural Land

Screening-Level Ecological Risk Assessment

COB Energy Facility, Klamath County, Oregon

				Oregon DEQ Screening Level Values [b]				Hazard Quotients -Incremental [c]				Hazard Quotients - Background [c]				Hazard Quotients -Total [c]			
Analyte	Incremental Soil Concentration (mg/kg)	Background (mg/kg) [a]	Total (Incremental) + Background) (mg/kg)	Plants	Inverts	Birds	Mammals	Plants	Inverts	Birds	Mammals	Plants	Inverts	Birds	Mammals	Plants	Inverts	Birds	Mammals
Inorganics																			
Aluminum	9.653	100000	100009.65	50	600	450	107	0.193	0.016	0.021	0.090	**2000.000**	**166.667**	**222.222**	**934.579**	**2000.193**	**166.683**	**222.244**	**934.670**
Ammonia as N	9.653	--	9.65	--	--	--	--												
Antimony	0.193	0	0.19	5	--	--	15	0.039			0.013	0.000			0.000	0.039			0.013
Arsenic	0.193	4.05	4.24	10	60	10	29	0.019	0.003	0.019	0.007	0.405	0.068	0.405	0.140	0.424	0.071	0.424	0.146
Barium	2.413	700	702.41	500	3000	85	638	0.005	0.001	0.028	0.004	**1.400**	0.233	**8.235**	**1.097**	**1.405**	0.234	**8.264**	**1.101**
Beryllium	0.386	1	1.39	10	--	--	83	0.039			0.005	0.100			0.012	0.139			0.017
Boron	26.677	20	46.68	0.5	20	120	3500	**53.354**	**1.334**	0.222	0.008	**40.000**	**1.000**	0.167	0.006	**93.354**	**2.334**	0.389	0.013
Cadmium	0.048	**1**	1.05	4	20	6	125	0.012	0.002	0.008	0.000	0.250	0.050	0.167	0.008	0.262	0.052	0.175	0.008
Calcium	1428.7	38000	39428.69	--	--	--	--												
Chloride	204.52	--	204.52	--	--	--	--												
Chromium III	0.097	**41.9**	42.00	1	0.4	4	340000	0.097	0.241	0.024	0.000	**41.900**	**104.750**	**10.475**	0.000	**41.997**	**104.991**	**10.499**	0.000
Chromium VI	0.193	--	0.19	--	--	--	410				0.000								0.000
Cobalt	0.965	15	15.97	20	1000		150	0.048	0.001		0.006	0.750	0.015		0.100	0.798	0.016		0.106
Copper	0.965	70	70.97	100	50	190	390	0.010	0.019	0.005	0.002	0.700	**1.400**	0.368	0.179	0.710	**1.419**	0.374	0.182
Fluoride	9.880	200	209.88	200	30	32	2285	0.049	0.329	0.309	0.004	**1.000**	**6.667**	**6.250**	0.088	**1.049**	**6.996**	**6.559**	0.092
Iron	6.916	**43106**	43112.92	10	200		--	0.692	0.035			**4310.600**	**215.530**			**4311.292**	**215.565**		
Lead	0.290	10	10.29	50	500	16	4000	0.006	0.001	0.018	0.000	0.200	0.020	0.625	0.003	0.206	0.021	0.643	0.003
Magnesium	580.0	20000	20579.97	--	--	--	--												
Manganese	0.988	600	600.99	500	100	4125	11000	0.002	0.010	0.000	0.000	**1.200**	**6.000**	0.145	0.055	**1.202**	**6.010**	0.146	0.055
Mercury	0.010	0.06	0.07	0.3	0.1	1.5	73	0.032	0.097	0.006	0.000	0.200	0.600	0.040	0.001	0.232	0.697	0.046	0.001
Molybdenum	2.413	3	5.41	2	200	15	14	**1.207**	0.012	0.161	0.172	**1.500**	0.015	0.200	0.214	**2.707**	0.027	0.361	0.387
Nickel	1.931	32.5	34.43	30	200	320	625	0.064	0.010	0.006	0.003	**1.083**	0.163	0.102	0.052	**1.148**	0.172	0.108	0.055
Nitrate as N	41.497	--	41.50	--	--	--	--												
Nitrite as N	0.988	--	0.99	--	--	--	--												
Phosphorous	2.470	750	752.47	--	--	--	--												
Potassium	208.47	13500	13708.47	--	--	--	--												
Selenium	0.193	0.1	0.29	1	70	2	25	0.193	0.003	0.097	0.008	0.100	0.001	0.050	0.004	0.293	0.004	0.147	0.012
Silver	0.048	--	0.05	2	50	--	--	0.024	0.001							0.024	0.001		
Sodium	994.0	22500	23493.96	--	--	--	--												
Strontium	9.653	700	709.65	--	--	--	32875				0.000				0.021				0.022
Sulfate	310.74	--	310.74	--	--	--	--												
Sulfide	96.53	--	96.53	--	--	--	--												
Sulfite	49.401	--	49.40	--	--	--	--												
Thallium	0.193	0	0.19	1	--	--	1	0.193			0.193	0.000			0.000	0.193			0.193
Tin	2.413	--	2.41	50	2000	--	--	0.048	0.001							0.048	0.001		
Titanium	9.653	--	9.65	--	1000	--	--		0.010								0.010		
Zinc	1.931	45	46.93	50	200	60	20000	0.039	0.010	0.032	0.000	0.900	0.225	0.750	0.002	0.939	0.235	0.782	0.002
Organics and Other Constituents																			
Cyanide, total	0.965	--	0.96530	--	--	--	--												
Oil & Grease	14.820	--	14.82	--	--	--	--												
Orthophosphate as P	2.470	--	2.47	--	--	--	--												
Phenol	0.483	--	0.48265	70	30	--	--	0.007	0.016							0.007	0.016		
TDS	10028	--	10028.50	--	--	--	--												
TSS	49.40	--	49.40	--	--	--	--												

Notes:

[a] Background values are the mean of Klamath County background concentrations reported by USGS (Boerngen, J. G. and H. T. Shacklette, 1981. Chemical Analyses of Soils and Other Surficial Materials of the Conterminous United States. U.S. Geological Survey, Open-File Report 81-197.). Italicized and bold values are Washington Statewide Background levels (San Jaun, C. 1994. Natural Background Soil Metals Concentrations in Washington State. Toxics Cleanup Program, Washington State Department of Ecology. Publication # 94-115, October.) and were used when Klamath County values were not available.

[b] Screening values from the Oregon Department of Environmental Quality (Guidance for Ecological Risk Assessment: Level II Screening Level Values, December 2001).

[c] Hazard Quotient (HQ) = soil concentration (Incremental, Background, or Total)/Oregon screening level value. Incremental HQs represent risk estimate from wastewater only; background HQs represent risk estimate from background levels; and total HQs represent the combined incremental and background risk.

-- Not available

Highlighted values represent exceedance of the screening levels.

TABLE 14

Exposure and Hazard Quotient (HQ) Calculations for Wastewater Constituents Lacking Oregon Department of Environmental Quality (ODEQ) Screening Values for Birds and Mammals

Screening-Level Ecological Risk Assessment

COB Energy Facility, Klamath County, Oregon

		Bioaccumulation Values		Exposure Estimates [c]				Literature Benchmarks				
Analytes	**Maximum Soil Concentration (mg/kg)**	**Plants [a]**	**Invertebrates [b]**	**Plant**	**Invert**	**Soil**	**Total**	**NOAEL (mg/kg/d)**	**LOAEL (mg/kg/d)**	**Source**	**NOAEL HQ**	**LOAEL HQ**
Incremental												
Western Meadowlark												
Antimony	0.19	0.1487	0.025	0.0004	0.0001	0.0002	0.0007					
Beryllium	0.39		0.0286		0.0003	0.0003	0.0006					
Cobalt	0.97	0.55	0.023	0.0079	0.0006	0.0008	0.0092	9.325	18.650	Diaz et al. 1994	0.001	0.000
Iron	6.92	1	0.027	0.1024	0.0047	0.0058	0.1128	41.807	NA	NRC 1980 in McDowell 1992	0.003	NA
Magnesium	579.97	7.333	1.5047	62.9435	21.9917	0.4825	85.4178					
Silver	0.05	1	0.12	0.0007	0.0001	0.0000	0.0009	11.447	NA	USEPA 1997	0.000	NA
Strontium	9.65					0.0080	0.0080					
Thallium	0.19	1	0.256	0.0029	0.0012	0.0002	0.0043	0.035	NA	Schafer 1972	0.120	NA
Tin	2.41	1	1	0.0357	0.0608	0.0020	0.0985	6.391	15.884	Schlatterer et al. 1993	0.015	0.006
Titanium	9.65					0.0080	0.0080					
Cyanide, total	0.96530	1	1	0.0143	0.0243	0.0008	0.0394					
Oil & Grease	14.82					0.0123	0.0123					
Orthophosphate as P	2.47					0.0021	0.0021					
Phenol	0.48265	5.5963	26.58	0.0400	0.3233	0.0004	0.3637					
Deer Mouse												
Iron	6.92	1	0.027	1.5561	0.0420	0.0622	1.6604	3.297	NA	Sobotka et al. 1996	0.504	NA
Magnesium	579.97	7.333	1.5047	956.9121	196.3542	5.2198	1158.4860					
Silver	0.05	1	0.12	0.0109	0.0013	0.0004	0.0126	2.418	24.182	Rungby and Dascher 1984	0.005	0.001
Tin	2.41	1	1	0.5430	0.5430	0.0217	1.1077	23.776	35.562	Davis et al. 1987	0.047	0.031
Titanium	9.65					0.0869	0.0869					
Cyanide, total	0.96530	1	1	0.2172	0.2172	0.0087	0.4431	79.693	NA	Tewe and Maner 1981	0.006	NA
Oil & Grease	14.82					0.1334	0.1334					
Orthophosphate as P	2.47					0.0222	0.0222					
Phenol	0.48265	5.5963	26.58	0.6077	2.8865	0.0043	3.4986	17.375	NA	Bishop et al. 1997	0.201	NA
Background												
Western Meadowlark												
Antimony		0.1487	0.025	0.0000	0.0000	0.0000	0.0000					
Beryllium	1		0.0286		0.0007	0.0008	0.0016					
Cobalt	15	0.55	0.023	0.1221	0.0087	0.0125	0.1433	9.325	18.650	Diaz et al. 1994	0.015	0.008
Iron	43106	1	0.027	637.9688	29.3293	35.8642	703.1623	41.807	NA	NRC 1980 in McDowell 1992	16.819	NA
Magnesium	20000	7.333	1.5047	2170.5680	758.3688	16.6400	2945.5768					
Silver		1	0.12	0.0000	0.0000	0.0000	0.0000	11.447	NA	USEPA 1997	0.000	NA
Strontium	700					0.5824	0.5824					
Thallium	0	1	0.256	0.0000	0.0000	0.0000	0.0000	0.035	NA	Schafer 1972	0.000	NA
Tin		1	1	0.0000	0.0000	0.0000	0.0000	6.391	15.884	Schlatterer et al. 1993	0.000	0.000
Titanium						0.0000	0.0000					
Cyanide, total		1	1	0.0000	0.0000	0.0000	0.0000					
Oil & Grease						0.0000	0.0000					
Orthophosphate as P						0.0000	0.0000					
Phenol		5.5963	26.58	0.0000	0.0000	0.0000	0.0000					
Deer Mouse												
Iron	43106	1	0.027	9698.8500	261.8690	387.9540	10348.6730	3.297	NA	Sobotka et al. 1996	3138.963	NA
Magnesium	20000	7.333	1.5047	32998.5000	6771.1500	180.0000	39949.6500					
Silver		1	0.12	0.0000	0.0000	0.0000	0.0000	2.418	24.182	Rungby and Dascher 1984	0.000	0.000
Tin		1	1	0.0000	0.0000	0.0000	0.0000	23.776	35.562	Davis et al. 1987	0.000	0.000
Titanium						0.0000	0.0000					

TABLE 14

Exposure and Hazard Quotient (HQ) Calculations for Wastewater Constituents Lacking Oregon Department of Environmental Quality (ODEQ) Screening Values for Birds and Mammals

Screening-Level Ecological Risk Assessment

COB Energy Facility, Klamath County, Oregon

		Bioaccumulation Values		**Exposure Estimates [c]**				**Literature Benchmarks**				
Analytes	**Maximum Soil Concentration (mg/kg)**	**Plants [a]**	**Invertebrates [b]**	**Plant**	**Invert**	**Soil**	**Total**	**NOAEL (mg/kg/d)**	**LOAEL (mg/kg/d)**	**Source**	**NOAEL HQ**	**LOAEL HQ**
Cyanide, total		1	1	0.0000	0.0000	0.0000	0.0000	79.693	NA	Tewe and Maner 1981	0.000	NA
Oil & Grease						0.0000	0.0000					
Orthophosphate as P						0.0000	0.0000					
Phenol		5.5963	26.58	0.0000	0.0000	0.0000	0.0000	17.375	NA	Bishop et al. 1997	0.000	NA
Total												
Western Meadowlark												
Antimony	0.19	0.1487	0.025	0.0004	0.0001	0.0002	0.0007					
Beryllium	1.39		0.0286		0.0010	0.0012	0.0022					
Cobalt	15.97	0.55	0.023	0.1300	0.0093	0.0133	0.1525	9.325	18.650	Diaz et al. 1994	0.016	0.008
Iron	43112.92	1	0.027	638.0712	29.3340	35.8699	703.2751	41.807	NA	NRC 1980 in McDowell 1992	16.822	NA
Magnesium	20579.97	7.333	1.5047	2233.5115	780.3605	17.1225	3030.9946					
Silver	0.05	1	0.12	0.0007	0.0001	0.0000	0.0009	11.447	NA	USEPA 1997	0.000	NA
Strontium	709.65					0.5904	0.5904					
Thallium	0.19	1	0.256	0.0029	0.0012	0.0002	0.0043	0.035	NA	Schafer 1972	0.120	NA
Tin	2.41	1	1	0.0357	0.0608	0.0020	0.0985	6.391	15.884	Schlatterer et al. 1993	0.015	0.006
Titanium	9.65					0.0080	0.0080					
Cyanide, total	0.96530	1	1	0.0143	0.0243	0.0008	0.0394					
Oil & Grease	14.82					0.0123	0.0123					
Orthophosphate as P	2.47					0.0021	0.0021					
Phenol	0.48265	5.5963	26.58	0.0400	0.3233	0.0004	0.3637					
Deer Mouse												
Iron	43112.92	1	0.027	9700.4061	261.9110	388.0162	10350.3334	3.297	NA	Sobotka et al. 1996	3139.467	NA
Magnesium	20579.97	7.333	1.5047	33955.4121	6967.5042	185.2198	41108.1360					
Silver	0.05	1	0.12	0.0109	0.0013	0.0004	0.0126	2.418	24.182	Rungby and Dascher 1984	0.005	0.001
Tin	2.41	1	1	0.5430	0.5430	0.0217	1.1077	23.776	35.562	Davis et al. 1987	0.047	0.031
Titanium	9.65					0.0869	0.0869					
Cyanide, total	0.96530	1	1	0.2172	0.2172	0.0087	0.4431	79.693	NA	Tewe and Maner 1981	0.006	NA
Oil & Grease	14.82					0.1334	0.1334					
Orthophosphate as P	2.47					0.0222	0.0222					
Phenol	0.48265	5.5963	26.58	0.6077	2.8865	0.0043	3.4986	17.375	NA	Bishop et al. 1997	0.201	NA

Notes:

[a] Bioaccumulation values for plants from CH2M HILL (2002) for all constituents, except cyanide, silver, thallium, and tin. No bioaccumulation values were available for these analytes; therefore a value of 1 was assumed.

[b] Bioaccumulation values for invertebrates (arthropods) from CH2M HILL (2002) for all constituents, except cyanide, and tin No bioaccumulation values were available for these analytes; therefore a value of 1 was assumed.

[c] Exposure estimates calculated using life-history parameters presented in Table 5.

Western Meadowlark
Body weight = 0.11 (Wiens and Innes 1974)
Food Ingestion Rate = 0.04 (Sample et al. 1997)
Diet = 37% plant and 63% invertebrate (Lanyon 1994)
Soil Ingestion = 2.08% (Sample et al. 1997)

Deer Mouse
Body weight = 0.023 (Silva and Downing 1995)
Food Ingestion Rate = 0.45 (USEPA 1993)
Diet = 50% plant and 50% invertebrate (USEPA 1993)
Soil Ingestion = 2% (adapted from Beyer et al. 1994)

Highlighted values represent exceedance of the screening levels.

Figure

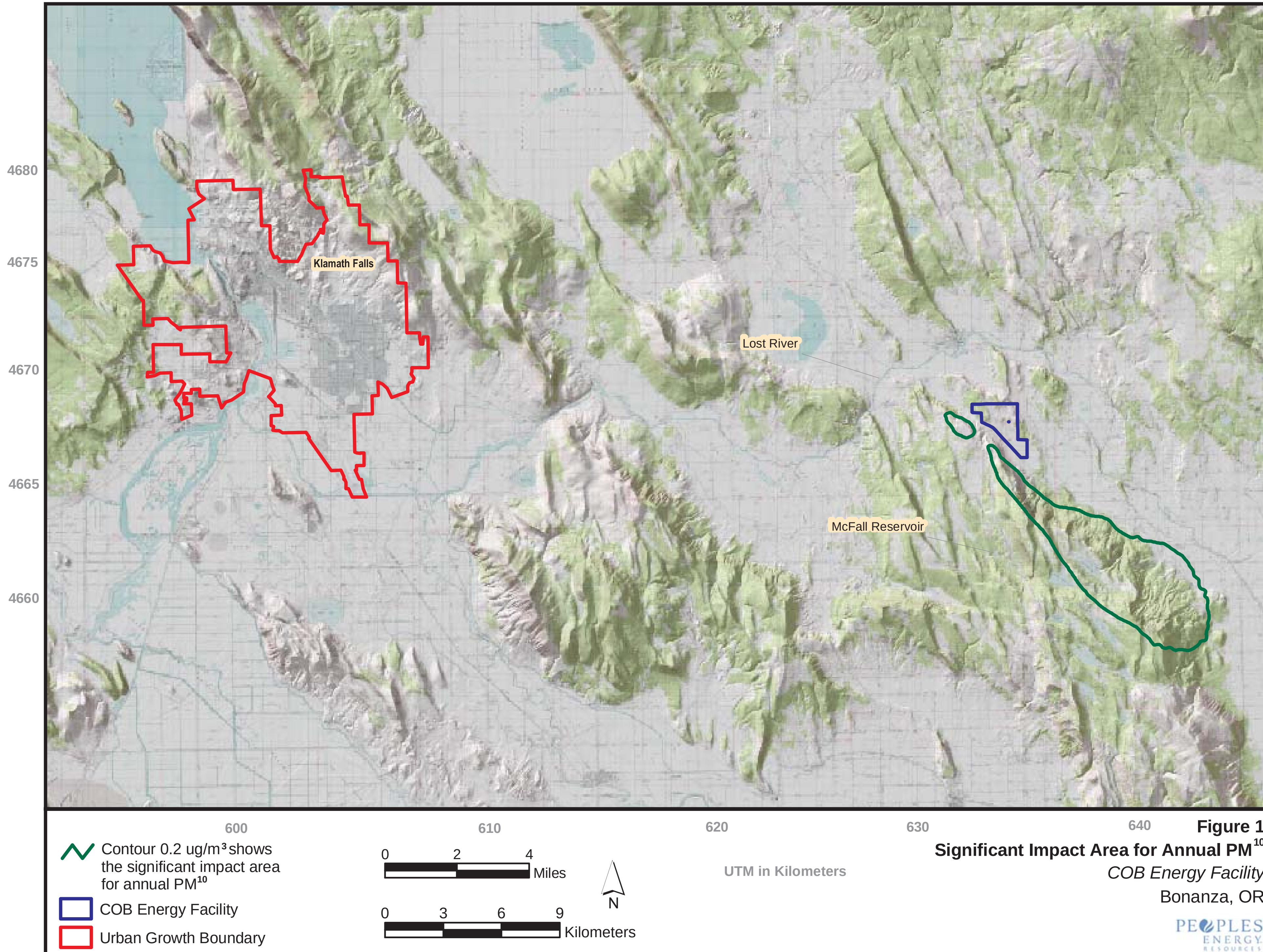

Figure 1
Significant Impact Area for Annual PM10
COB Energy Facility
Bonanza, OR

Attachment

Descriptions of Studies Used to Calculate NOAELs and LOAELs

Study descriptions for no observed adverse effect levels (NOAELs) and lowest observable adverse effect levels (LOAELs) developed by EFA West (1998) are presented in that document and are not shown below. Additionally, acute studies (e.g., silver and thallium for birds and polyacrylate for mammals) are not described below as these studies are self-descriptive.

Compound: Arsenic

Form: Sodium arsenate

Reference: Stanley et al., 1994

Test Species: mallard
Body weight: 1 kg (Heinz et al., 1989)
Food Consumption: 0.1 kg/d (Heinz et al., 1989)

Exposure Duration: 4 wks prior to breeding, through nesting, incubation, and hatch, to 14 d post hatch (> 10 week and during critical lifestage=chronic)

Endpoint: reproduction

Exposure Route: oral in diet

Dosage: 4 dose levels (As concentrations measured in food)
0.26, 22, 93, and 403 mg/kg

Calculations:

$$\left(\frac{0.26\,mg\ As}{kg\ food}\,x\,\frac{100\,g\ food}{day}\,x\,\frac{1\,kg}{1000\,g}\right)/1\,kg\ BW = 0.026\,mg/kg/d$$

$$\left(\frac{22\,mg\ As}{kg\ food}\,x\,\frac{100\,g\ food}{day}\,x\,\frac{1\,kg}{1000\,g}\right)/1\,kg\ BW = 2.2\,mg/kg/d$$

$$\left(\frac{93\,mg\ As}{kg\ food}\,x\,\frac{100\,g\ food}{day}\,x\,\frac{1\,kg}{1000\,g}\right)/1\,kg\ BW = 9.3\,mg/kg/d$$

$$\left(\frac{403\,mg\ As}{kg\ food}\,x\,\frac{100\,g\ food}{day}\,x\,\frac{1\,kg}{1000\,g}\right)/1\,kg\ BW = 40.3\,mg/kg/d$$

Comments: Although As did not increase duckling mortality, As at 40.3 mg/kg/d significantly reduced duckling production. No reductions in duckling production or other adverse effects were observed at the other dose levels. Because the study considered exposure over 10 weeks and through reproduction, the 40.3 mg/kg/d dose was considered to be a chronic LOAEL.

Final NOAEL: 9.3 mg/kg/d

Final LOAEL: 40.3 mg/kg/d

Compound: Arsenic

Form: Sodium arsenite (51.35% As^{+3})

Reference: USFWS 1964

Test Species: Mallard ducks

Body weight: 1 kg (Heinz et al. 1989)

Food Consumption: 0.100 kg/d (Heinz et al. 1989)

Exposure Duration: 128 d (> 10 wk=chronic)

Endpoint: mortality

Exposure Route: oral in diet

Dosage: four dose levels (nominal):

100, 250, 500, and 1000 ppm Sodium Arsenite;

NOAEL = 100 ppm

mg/kg As^{+3} = 0.5135 x 100 mg/kg = 51.35 mg/kg

Calculations:

$$\left(\frac{51.3\, mg\ As^{+3}}{kg\ food} x \frac{100\, g\ food}{day} x \frac{1\, kg}{1000\, g}\right) / 1\, kg\ BW = 5.135\, mg / kg / d$$

$$\left(\frac{128.375\, mg\ As^{+3}}{kg\ food} x \frac{100\, g\ food}{day} x \frac{1\, kg}{1000\, g}\right) / 1\, kg\ BW = 12.837\, mg / kg / d$$

$$\left(\frac{256.75\, mg\ As^{+3}}{kg\ food} x \frac{100\, g\ food}{day} x \frac{1\, kg}{1000\, g}\right) / 1\, kg\ BW = 25.675\, mg / kg / d$$

$$\left(\frac{513.5\, mg\ As^{+3}}{kg\ food} x \frac{100\, g\ food}{day} x \frac{1\, kg}{1000\, g}\right) / 1\, kg\ BW = 51.35\, mg / kg / d$$

Comments: Mallards in the 1000, 500, and 250 ppm groups experienced 92%, 60%, and 12% mortality, respectively. Because those in the 100 ppm group experienced 0% mortality, and the study considered exposure over 128 days, the 100 ppm Sodium Arsenite (51.35 mg/kg As^{+3}) dose was considered to be a chronic NOAEL. The 250 ppm Sodium Arsenite (128.375 mg/kg As^{+3}) dose was considered to be a chronic LOAEL.

Final NOAEL: 5.14 mg/kg/d

Final LOAEL: 12.84 mg/kg/d

Compound: Cadmium

Form: Cadmium Chloride

Reference: White and Finley 1978

Test Species: Mallard Ducks

Body weight: 1.153 kg (from study)

Food Consumption: 0.110 kg/d (from study)

Study Duration: 90 d (> 10 wk and during a critical lifestage =chronic)

Endpoint: reproduction

Exposure Route: oral in diet
Dosage: 4 dose level:
0.08, 1.6, 15.2, and 210 ppm Cd
NOAEL = 15.2 ppm
Calculations:

$$\left(\frac{15.2\,mg\;Cd}{kg\;food}\,x\,\frac{0.110\,kg\;food}{day}\right)/\,1.153\,kg\;BW = 1.45\,mg\,/\,kg\,/\,d$$

$$\left(\frac{210\,mg\;Cd}{kg\;food}\,x\,\frac{0.110\,kg\;food}{day}\right)/\,1.153\,kg\;BW = 20\,mg\,/\,kg\,/\,d$$

Comments: Mallards in the 210 ppm group produced significantly fewer eggs than those in the other groups. Because the study considered exposure over 90 days, the 15.2 ppm Cd dose was considered to be a chronic NOAEL and the 210 ppm does was considered to be a chronic LOAEL.
Final NOAEL: 1.45 mg/kg/d
Final LOAEL: 20 mg/kg/d

Compound: Chromium
Form: Cr^{+3} as $CrK(SO_4)_2$
Reference: Haseltine et al. 1985
Test Species: Black duck
Body weight: 1.25 kg ($mean_{male+female}$; Dunning 1993)
Food Consumption: Congeneric Mallard ducks, weighing 1 kg consume 100 g food/d (Heinz et al.1989). Therefore, it was assumed that a 1.25 kg black duck would consume 125 g food/d.
Study Duration: 10 mo. (>10 weeks and during a critical lifestage = chronic)
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: two dose levels:
10 and 50 ppm Cr^{+3} in diet; NOAEL = 10 ppm

$$\left(\frac{10\,mg\;Cr^{+3}}{kg\;food}\,x\,\frac{125\,g\;food}{day}\,x\,\frac{1\,kg}{1000\,g}\right)/\,1.25\,kg\;BW = 1\,mg\,/\,kg\,/\,d$$

$$\left(\frac{50\,mg\;Cr^{+3}}{kg\;food}\,x\,\frac{125\,g\;food}{day}\,x\,\frac{1\,kg}{1000\,g}\right)/\,1.25\,kg\;BW = 5\,mg\,/\,kg\,/\,d$$

Comments: While duckling survival was reduced at the 50 ppm dose level, no significant differences were observed at the 10 ppm Cr^{+3} dose level. Because the study considered exposure throughout a critical lifestage (reproduction), the dose 50 ppm dose was considered to be a chronic LOAEL and the dose 10 ppm dose was considered to be a chronic NOAEL.
Final NOAEL: 1 mg/kg/d
Final LOAEL: 5 mg/kg/d

Compound: Cyanide
Form: Potassium Cyanide
Reference: Tewe and Maner 1981
Test Species: Rat
Body weight: 0.273 kg (from study)
Food Consumption: 0.0375 kg/d (from study)
Study Duration: gestation and lactation (during a critical lifestage = chronic)
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: one dose level:
500 ppm CN = NOAEL
Calculations:

$$\left(\frac{500\,mg\;CN}{kg\;food} x \frac{37.5\,g\;food}{day} x \frac{1\,kg}{1000\,g} \right) / \, 0.273\,kg\;BW = 68.7\,mg\,/\,kg\,/\,d$$

Comments: Consumption of 500 ppm CN significantly reduced offspring growth and food consumption, however values for treated individuals were only marginally less than controls (reductions were 7% or less). While the effects of 500 ppm CN in the diet were statistically significant, they were not considered to be biologically significant. Because the study considered exposure throughout a critical lifestage (reproduction), this dose was considered to be a chronic NOAEL.

Final NOAEL:68.7 mg/kg/d

Compound: Iron
Form: Fe
Reference: NRC 1980 in McDowell 1992
Test Species: poultry
Body weight: 1.5 kg (EPA 1988)
Food Consumption: 0.106 kg/d (calculated using allometric equation from EPA 1988)
Study Duration: chronic
Endpoint: maximum tolerable level
Exposure Route: oral in diet
Dosage: McDowell (1992) reports the maximum tolerable level of 1000 ppm Fe in diet for poultry.
Calculations:

$$\left(\frac{1000\,mg\;Fe}{kg\;food} x \frac{106\,g\;food}{day} x \frac{1\,kg}{1000\,g} \right) / \, 1.5\,kg\;BW = 70.5\,mg\,/\,kg\,/\,d$$

Comments: The maximum tolerable level reported for poultry (1000 ppm Fe in diet) was assumed to be the chronic NOAEL. Body weight and food consumption rate are those for white leghorn chickens and are derived from EPA (1988).

Final NOAEL: 70.5 mg/kg/d

Compound: Manganese

Form: Manganese oxide (Mn_3O_4)

Reference: Laskey and Edens 1985

Test Species: Japanese Quail (males only, starting at 1 day old)
Body weight: 0.072 kg (for 3 wk-old male quail; Shellenberger 1978)

Study Duration: 75 d (>10 weeks = chronic)

Endpoint: growth, aggressive behavior

Exposure Route: oral in diet

Dosage: one dose level:
5000 ppm supplemented Mn + 56 ppm Mn in base diet = NOAEL

Calculations: NA

Comments: While no reduction in growth was observed, aggressive behavior was 25% to 50% reduced relative to controls. Daily Mn consumption was reported to range from 575 mg/kg/day for adults at the end of the study and 977 mg/kg/d for 20 d-old birds. Because the study was >10 weeks in duration, the 977 mg/kg/d dose was considered to be a chronic NOAEL based on a growth endpoint and a chronic LOAEL based on a behavior endpoint. A chronic behavior NOAEL was estimated by applying an LOAEL-NOAEL UF of 0.1

Final NOAEL$_{growth}$: 977 mg/kg/d

Final NOAEL$_{behavior}$: 98 mg/kg/d

Final LOAEL$_{behavior}$: 977 mg/kg/d

Compound: Mercury

Form: methyl mercury chloride/dicyandiamide

Reference: Heinz (1976) and Heinz and Hoffman (1998)

Test Species: mallard
Body weight: 1 kg (Heinz et al. 1989)
Food Consumption: 0.128 kg/d (from Heinz 1979)

Study Duration: 2 generations (lowest doses), 2.5 months (highest dose) (during a critical lifestage = chronic).

Endpoint: reproduction

Exposure Route: oral in diet

Dosage: four dose levels:

0, 0.53, 2.88, and 9.2 ppm Hg

Calculations:

$$\left(\frac{0.53\, mg\ Hg}{kg\ food}\, x\, \frac{0.128\, kg\ food}{day}\right) / \, 1\, kg\ BW = 0.068\, mg/kg/d$$

$$\left(\frac{2.88\, mg\ Hg}{kg\ food}\, x\, \frac{0.128\, kg\ food}{day}\right) / \, 1\, kg\ BW = 0.37\, mg/kg/d$$

$$\left(\frac{9.2\ mg\ Hg}{kg\ food}\ x\ \frac{0.128\ kg\ food}{day}\right) /\ 1\ kg\ BW = 1.18\ mg/kg/d$$

Comments: Although duckling survival at 7 days was significantly reduced at the two highest dose levels, no significant difference was observed at the 0.068 mg/kg/d dose. Because exposure occurred during reproduction, the 0.37 mg/kg/d dose was considered to be a chronic LOAEL.

Final NOAEL: 0.068 mg/kg/d
Final LOAEL: 0.37 mg/kg/d

Compound: Nickel
Form: Nickel Sulfate
Reference: Cain and Pafford 1981
Test Species: Mallard Duckling
Body weight: 0.782 kg (mean$_{\text{control male+female}}$ at 28 and 60 days; from study)
Food Consumption: Adult Mallard ducks, weighing 1 kg consume 100 g food/d (Heinz et al. 1989). Therefore, it was assumed that a 0.782 kg mallard duckling would consume 78.2 g food/d.
Study Duration: 90 d (>10 week = chronic)
Endpoint: mortality, growth, behavior
Exposure Route: oral in diet
Dosage: three dose levels:
176, 774, and 1069 ppm Ni;
NOAEL = 176 ppm
Calculations:

$$NOAEL: \left(\frac{176\,mg\ Ni}{kg\ food} \times \frac{78.2\,g\ food}{day} \times \frac{1kg}{1000\,g}\right) / 0.782\,kg\ BW\ = 17.6\ mg/kg/d$$

$$LOAEL: \left(\frac{774\,mg\ Ni}{kg\ food} \times \frac{78.2\,g\ food}{day} \times \frac{1kg}{1000\,g}\right) / 0.782\,kg\ BW\ = 77.4\ mg/kg/d$$

Comments: While consumption of up to 774 ppm Ni in diet resulted in a significant increase in tremors and joint edema, 176 ppm did not. Because the study considered exposure over 90 days, the 176 ppm dose was considered to be a chronic NOAEL and the 774 ppm dose was considered to be a chronic LOAEL. To estimate daily Ni intake throughout the 90 day study period, food consumption of 45-day-old ducklings was calculated. While this value will over- and underestimate food consumption by younger and older ducklings, it was assumed to approximate food consumption throughout the entire 90-day study.

Final NOAEL: 17.6 mg/kg/d
Final LOAEL: 77.4 mg/kg/d

Compound: Nickel
Form: Nickel sulfate and nickel acetate
Reference: Weber and Reid 1968

Test Species: Chicks
Body weight: 0.45 kg (EPA 1988)
Food Consumption: 0.038 kg/d (calculated using allometric equation from EPA 1988)
Study Duration: 4 weeks
Endpoint: growth, metabolism
Exposure Route: oral in diet
Dosage: 8 dose levels:
0, 100, 300, 500, 700, 900, 1100, 1300 mg Ni/kg
Calculations:

Doses (mg/kg/d) estimated based on data presented by authors								
Ni in diet	0	100	300	500	700	900	1100	1300
Sulfate	0	5.8	16.9	31.0	39.1	57.3	74.0	95.4
Acetate	0	5.9	16.5	28.3	40.7	56.4	67.4	93.7

Comments: No significant differences were obtained in growth at doses below 500 ppm. Significant differences in growth were noticed in doses starting at 500 ppm. This dose is considered a subchronic LOAEL, the 300 ppm dose is a subchronic NOAEL.
Final NOAEL: 25.3 mg/kg/d
Final LOAEL: 42.2 mg/kg/d

Compound: Silver
Form: $AgNO_3$ (63.5% Ag)
Reference: Rungby and Danscher 1984
Test Species: mouse
Body weight-0.03 kg (EPA 1988)
Exposure duration: 125 days
Endpoint: activity
Exposure route: oral in water
Dosage: one dose level (concentration is in $AgNO_3$)
0.015% $AgNO_3$ = 150 mg/L $AgNO_3$=95.25 mg/L Ag
Calculations:

$$\left(\frac{95.25 \text{ mg Ag}}{\text{L}} \text{x} \frac{0.0075 \text{ ml}}{\text{.day}}\right) / 0.03\, kg = 23.8 \text{ mg Ag/kg/day}$$

Comments: A significant reduction in activity was observed among treated mice. Because the study was performed over 125 days, the 23.8 mg/kg/d dose was considered a chronic LOAEL. A chronic NOAEL was estimated by multiplying the LOAEL by a LOAEL-NOAEL uncertainty factor of 0.1.
Final NOAEL: 2.38 mg/kg/day
Final LOAEL: 23.8 mg/kg/day

Compound: Phenol
Form: not applicable
Reference: Bishop et al. 1997
Test Species: Mouse

Exposure Duration: 347 days (during critical lifestage = chronic)
Endpoint: reproduction
Exposure Route: intraperitoneal
Dosage: one dose level:
350 mg/kg (1 ip injection prior to each of 17 breeding cycles)
Calculations: normalized 17 doses of 350 mg/kg over 347 days
17.1 mg/kg/d

Comments: No effects on reproductive performance were observed. Because injections were given at critical lifestage periods, a dose of 17.1 mg/kg/d was considered to be the chronic NOAEL.

Final NOAEL: 17.1 mg/kg/d

Compound: Tin
Form: bis (Tributyltin) oxide (TBTO)
Reference: Davis et al. 1987
Test Species: mouse
Body weight: 0.03 kg (EPA 1988a)
Study Duration: days 6-15 of gestation (during a critical lifestage = chronic)
Endpoint: reproduction
Exposure Route: oral intubation
Dosage: six dose levels:
1.2, 3.5, 5.8, 11.7, 23.4, and 35 mg/kg/d;
NOAEL= 23.4 mg/kg/d
Calculations: not applicable

Comments: Mice dosed with 35 mg/kg/d TBTO displayed reduced fetal weight and fetal survival and increased frequency of litter resorption. Adverse effects were not observed at lower dose levels. Because the study considered exposure during gestation, the 23.4 and 35 mg/kg/d dose levels were considered to be chronic NOAELs and LOAELs, respectively.

Final NOAEL: 23.4 mg/kg/d
Final LOAEL: 35 mg/kg/d

Compound: Tin
Form: bis (Tributyltin) oxide (TBTO)
Reference: Schlatterer et al. (1993)
Test Species: Japanese Quail
Body weight: 0.15 kg (Vos et al. 1971)
Food consumption: 0.0169 kg/d (calculated using allometric equation of Nagy 1987)
Study Duration: 6 wks (during a reproduction = chronic)
Endpoint: reproduction
Exposure Route: oral in diet
Dosage: four dose levels:
24, 60, 150, and 375 mg/kg in diet;
NOAEL= 60 mg/kg

Calculations:

$$NOAEL:\left(\frac{60\,mg\,TBTO}{kg\ food}\times\frac{16.9\,g\ food}{day}\times\frac{1\,kg}{1000\,g}\right)/\,0.15\,kg\,BW\,=6.76\ mg\,/\,kg\,/\,d$$

$$LOAEL:\left(\frac{150\,mg\,TBTO}{kg\ food}\times\frac{16.9\,g\ food}{day}\times\frac{1\,kg}{1000\,g}\right)/\,0.15\,kg\,BW\,=16.9\ mg\,/\,kg\,/\,d$$

Comments: While egg weight and hatchability were reduced among quail consuming diets containing 150 mg TBTO/kg, no consistent adverse effects were observed among the 60 mg/kg groups. Because the study considered exposure during reproduction, the 60 and 150 mg/kg dose levels were considered to be chronic NOAELs and LOAELs, respectively.

Final NOAEL: 6.8 mg/kg/d

Final LOAEL: 16.9 mg/kg/d

APPENDIX D

Literature Research on Potential Noise Impacts to Wildlife

APPENDIX D TO THE BIOLOGICAL ASSESSMENT

Literature and Research on Potential Noise Impacts to Wildlife

Introduction

The proposed COB Energy Facility would be a combined-cycle electric generating facility fired solely on natural gas. The biological assessment (BA) contains a detailed description of the Energy Facility and its associated related and supporting facilities, collectively referred to as the Facility. This attachment describes available literature and research conducted on potential noise impacts to wildlife.

Conclusion

Construction of the Facility would result in sporadic noise at a level approximately similar to the noise resulting from existing farm operations, but Facility noise would be more frequent during the construction period. Construction noise may result in some reduced wildlife use of habitat areas directly around the Energy Facility site, but this reduced use would be limited in scope and temporary.

During operations, noise levels are predicted to be 40 decibels on an A-weighted scale (dBA) or lower at the closest wildlife habitat area to the Energy Facility and the project proponent's proposed mitigation area. This level would be well below the levels documented to have adverse affects on wildlife (Bowles, 1995; CDT et al., 1995). It is expected that wildlife would habituate to the continuous, relatively low operational noise levels and that operational noise would not appreciably reduce the quality of habitat areas surrounding the Facility.

Results of Prior Research

Most of the research that addresses behavioral effects of noise on wildlife has focused on the effects of loud, sudden, intermittent noises from airplanes, helicopters, military exercises, and off-road vehicles in laboratory experiments. Specific effects of noise on wildlife are highly dependent on the particular characteristics of the noise and whether a visual stimulus is associated with it. Data indicate that human activity results in wildlife responding through one of three adaptation mechanisms: (1) avoidance, (2) habituation, or (3) attraction (Knight and Temple, 1995). Avoidance of the area may result in (1) no measurable effect, (2) reduced fitness, potentially decreasing over winter survival, or (3) decreased reproduction (i.e., individual animals may not reproduce or reproduction may be unsuccessful because of decreased available resources or abandonment of offspring to escape disturbance).

Impulse or intermittent noise is defined as a high-intensity, short duration, and sporadic or unpredictable sound, such as pile driving, dump trucks, gunshot, explosion, low-elevation airplanes, or a collision. There is evidence that such impulse noises can result in adverse physical, physiological, and behavioral effects on wildlife (Larkin, 1996).

On the other hand, continuous noise is less likely to result in adverse effects to wildlife, as many animals become habituated to the presence of the elevated noise levels (Conomy et al., 1998; Weisenberger et al., 1996). For example, domestic pigs showed no change in behavior when subject to a constant noise level exceeding 80 dBA, but demonstrated significant aversion to the same noise level played intermittently (Talling et al., 1998). Habituation is defined as "the elimination of the organism's response to often recurring, biologically irrelevant stimuli without impairment of its reaction to others" (Lorenz,1965). Thus, habituation to increased noise levels should not interfere with mating, distress, or warning calls. This phenomenon has been demonstrated in laboratory studies in which hooded rats exposed to background noise of 70 dB sound pressure level (SPL) showed the same startle response to a range of sounds as rats which were not exposed to the background noise (Blaszczyk and Tajchert, 1997).

In some instances, long-term exposure to continuous noise may help protect animals from adverse effects of more extreme impulse noises through sound conditioning (McFadden et al., 2000). It is therefore possible that increased background noise from the Energy Facility would help minimize the effects of noise spikes from farm equipment in the proposed Facility area.

Existing Conditions at the Facility Site

Habituation has been found to be highly variable among species (Conomy et al., 1998). However, it is likely that the species currently occupying the sage scrub habitats near the Energy Facility site have developed some habituation based on the present ambient noise levels from farm equipment and noise from existing electric transmission lines.

The primary source of background noise at the Energy Facility site is farm equipment on West Langell Valley Road and in adjacent fields. Measurements of ambient noise levels indicate the current ambient noise level is approximately 20 to 30 dBA with peaks exceeding 70 dBA near farm equipment (see Exhibit X). Levels may be greater along the road. Modeled estimates of plant operational noise indicate that the ambient noise at the edge of the Energy Facility site would be a continuous level of approximately 60 dBA. Noise during operations would dissipate with distance to approximately 30 dBA within 4,000 to 6,000 feet of the Energy Facility (see Figure 5-2 in the BA). Topographic buffering from surrounding hills would reduce the effective noise from the Energy Facility.

Analysis of Potential Impacts from Construction Noise

During construction, temporary and intermittent noise levels from typical construction equipment at 50 feet are expected to be 73 to 88 dBA. The noise levels at 3,000 feet are expected at 37 to 52 dBA.

Both mammals and birds can suffer temporary hearing impairment from 24-hour exposure to noise levels of 80 to 110 dB (CDT et al., 1995). While many species acclimate to elevated noise levels resulting from human activities, excessive, intermittent noise levels can be detrimental to wildlife. High levels of noise can cause hearing loss and other adverse physiological affects to wildlife, as well as behavioral modification such as moving to areas outside their home range. Activities that generally involve high levels of intermittent or impulse noise such as loud construction noise, low flying aircraft , military training activities, or off-road vehicles that stress wildlife into an avoidance response, have adverse effects on wildlife (Maier et al., 1998; Larkin, 1996).

Sporadic noise associated with heavy construction equipment and related construction activities may cause many species to either abandon areas directly adjacent to construction, alter use patterns to access habitat when construction is not occurring, or cause increased stress. For example, evidence suggests that terrestrial wildlife stratify themselves from roads based on the distance they can detect vehicle noise (Knight and Temple, 1995).

Accordingly, it is expected that the temporary construction noise from the Energy Facility site would cause some wildlife species to reduce their use of nearby habitats during the construction period. Major earthwork activity for the Energy Facility closest to wildlife habitat areas are expected to occur during a short period of 6 months out of the 23-month construction time frame. Similarly, piling driving for the Energy Facility would occur during a short, approximately 4-month period.

The extent of these indirect disturbances would depend on the particular tolerances of species. Because of the location of the proposed Energy Facility site in a low area (relative to surrounding topography) and the short duration of the loudest construction activity, noise impacts to nearby habitat areas is likely to be minimized.

Construction noise is not likely to result in direct physiological impacts to wildlife. Some species, such as nesting birds, deer, and others, may modify their behavior when construction noise is present by moving foraging and nesting locations slightly. However, most noise-related nest abandonments last for less than 5 minutes (Knight and Temple, 1995). Vertebrate species often habituate or adapt behaviorally and physiologically to repeated exposure to noise either through sensitization or avoidance (Bowles, 1995). Individual animals may reoccupy habitats once they become habituated. This does not mean that wildlife would continue to use the area as they did before the noise, but that their avoidance distance is expected to decline as they habituate to the disturbance.

Operations Noise

Operational noise disturbances would be substantially lower compared to construction noise. Noise levels decrease with distance and, as shown on Figure 5-2 in the BA noise levels are predicted to be 50 dBA at a distance of approximately 1,000 feet from the Energy Facility. Noise levels are predicted to be 40 dBA at a distance of approximately 2,500 feet from the Energy Facility, where habitats may be used by wildlife.

In addition, animals are more likely to habituate to a relatively constant noise level during operations than to impulse or sporadic noise during construction. In fact, constant natural noise is part of every environment and wildlife have developed adaptations to noise long before the advent of modern technology. In some instances natural ambient sounds along with diverse vegetation structure can reduce the direct effects of human noises on wildlife. Natural waterfalls can have continuous noise levels of 76 dBA, and many species of wildlife occupy areas with waterfalls. White-tailed deer were shown to habituate to snowmobile noise after some years of exposure. However, in areas with no previous exposure, deer might increase the area in which they home range in an effort to avoid snowmobile trails, potentially causing deer to expend more energy (stress) and endangering their health during the winter season (Radle, undated).

Continuous sound pressure levels at 70dB are considered a safe limit to wildlife (Bowles, 1995). The nearest wildlife habitat area is approximately 2,500 feet from the Energy Facility and the predicted noise level during operations at this distance is 40 dBA (see Figure 5-2 in the BA). This same general area is where the project proponent proposes to mitigate for permanently disturbed habitat by restoring, enhancing, and protecting habitat in accordance with ODFW habitat mitigation goals and pursuant to the revegetation plan described in Attachment P-1. Based on Figure 5-2 in the BA, operations noise levels are predicted to be 40 dBA or lower at the mitigation area. This level would be well below the reported levels (80 to 100 dB SPL) known to be detrimental to wildlife.

Biological surveys around the Energy Facility site found no evidence of wildlife species that would be uniquely sensitive to sound. Given the background noise levels from farm equipment, it is more than likely that the species currently inhabiting the area around the Energy Facility site can become habituated to a slight increase in continuous noise levels. Based on the best available information, the existing sound levels, and the estimated noise increases, it is not expected that operation of the Energy Facility would result in adverse effects on the wildlife inhabiting area around the Energy Facility site.

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APPENDIX E

Avian Collision Monitoring Plan

Report

Avian Collision Monitoring Plan

Prepared for

U.S. Fish and Wildlife Service

October 2003

COB Energy Facility, LLC

Prepared by

CH2MHILL

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Contents

1. Introduction

This section provides an overview of the project, a description of the electric transmission line and power stacks, and a summary of the proposed mitigation measures.

Project Description and Background

This monitoring plan describes how the site certificate applicant or "project proponent" (COB Energy Facility, LLP) would monitor for bird impacts, if any.

The electric transmission line route would cross natural habitats west of Bryant Mountain, including sagebrush-steppe, juniper sage, and ponderosa pine habitats. These habitats provide upland forage habitat for bald eagle and other birds in the area. The bald eagle is a federally-threatened species that nests within 3 miles of the Energy Facility where the stacks would be located and the electric transmission line route would pass within 2 miles of the nests. The nests are located around McFall Reservoir as shown in Figure E-1.

Other raptors in the project area include Northern goshawk, red-tailed hawk, Northern harrier, white-tailed kite, Swainson's hawk, and turkey vulture. Additional bird species known to occur within the project area include tri-colored blackbird, greater sage-grouse, black tern, olive-sided flycatcher, yellow rail, willow flycatcher, yellow-breasted chat, western least bittern, mountain quail, American white pelican, and Lewis' woodpecker.

Electric Transmission Line and Stack Descriptions

The COB Energy Facility would deliver electric power to the regional power grid by a new electric transmission line, approximately 7.2 miles in length, from the Energy Facility site to the Bonneville Power Administration (BPA) Captain Jack Substation. Approximately 38 transmission towers would be required. Typical transmission towers would range in height from 100 to 165 feet, with most towers in the 105- to 110-foot range. On average, the towers would be spaced approximately 990 feet apart, with a range from 380 to 1,500 feet. Two parallel groundwires would be strung on top of the transmission towers for protection from lightening. Groundwires typically would be thinner in diameter than conductor wires. Groundwires would not conduct electricity.

The electric transmission line would run cross-country in a north-south direction west of Bryant Mountain (Figure 2-2 in the Biological Assessment [BA]). Access for travel by wheeled vehicles would be required for construction and to access the new electric transmission line for maintenance during operation. Access would occur through approximately 6.6 miles of new access roads and the use of approximately 4.9 miles of existing roads. Figure 2-2 in the BA shows the route of the electric transmission line.

The proposed stacks are 150 to 200 feet tall with a diameter of 18 feet each. The stacks would be located within the security fence of the Energy Facility. They would be positioned approximately 200 feet apart and would be constructed of steel. Carbon dioxide, water, nitrogen, and air are the primary gases exhausted by the stacks along with oxides of nitrogen, carbon monoxide, and fine particulates.

Mitigation Measures

Mitigation measures are being developed for the project through consultation with the United State Fish and Wildlife Service (USFWS) under Section 7 of the Endangered Species Act (ESA). In addition, BPA, Oregon Department of Fish and Wildlife (ODFW), and the United States Bureau of Land Management (BLM) were consulted for appropriate measures that would minimize impacts to bald eagles (and other birds) from collisions and electrocutions. The resulting mitigation measures include:

- Locate the new electric transmission line route to avoid areas of dense bald eagle populations.
- Locate the new electric transmission line away from the three existing transmission line to avoid creating a cluster of electric transmission lines or a “net effect” that would pose additional obstacles to flight.
- Install colored bird flight diverters (BFDs) or swan flight diverters (SFDs) to allow better avian visualization of the thin groundwires during fog and rain events (Figure E-1).
- Design the conductor wires for spacing greater than the wing spans of large birds (24 feet on the vertical and 25 feet on the diagonal) to prevent electrocutions (Figure E-1).
- Conduct annual monitoring of the new electric transmission line.

2. Monitoring Plan Objectives

This section summarizes plan objectives based on the federal Endangered Species Act and the Migratory Bird Treaty Act.

Federal Endangered Species Act

Projects subject to the federal ESA require consultation with USFWS on impacts to federally-listed species. During informal consultation with USFWS, the project proponent anticipated that special-status birds could be incidentally taken as a result of implementing the proposed project.

The special-status bird species anticipated to be in the project area include bald eagle, peregrine falcon, greater sandhill crane, Aleutian Canada goose, and Swainson's hawk. These species are listed as threatened or endangered by USFWS or ODFW. The BA prepared for formal consultation under the ESA describes the potential significant impacts to federally-listed species and mitigation measures expected to avoid and/or minimize unavoidable impacts. To minimize impacts to bald eagles and other birds in the project area, the project proponent would install bird flight diverters and implement a monitoring program for bird collisions.

The USFWS Biological Opinion (BO) or authorizations would identify the amount or extent of incidental take allowed by the proposed project. Incidental take is defined in the Endangered Species Act as take (to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect a listed species) that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Incidental take of listed species could occur incidental of the COB Energy Facility project if bald eagle or other special-status birds collide with the new electric transmission line or the stacks at the Energy Facility.

The significance criteria used in this monitoring plan are the number of each listed bird species allowed by USFWS to be taken incidental to the project. The significance criteria (number of birds allowed) would be defined in the BO. Monitoring plan objectives include describing the methods that would be used to determine if the significance criteria are exceeded, and determining whether BFDs deflect the bald eagle, and other special-status bird species sufficiently to meet the USFWS incidental take restrictions.

Migratory Bird Treaty Act

In addition to the ESA, the Migratory Bird Treaty Act (MTBA) provides federal protection for migratory waterfowl and resident herons, egrets, ducks, and raptors. The MBTA prohibits the take, possession, import, export, transport, selling, purchase, barter, or offering for sale, purchase or barter, any migratory bird, their eggs, parts, and nests, except as authorized under a valid permit (50 CFR 21.11). The installation of BFDs on the electric transmission line along with the implementation of an avian collision monitoring program would minimize impacts to migratory bird species.

3. Methods

The methods described in this section would be used to determine whether (1) the significance criteria for bald eagles incidentally taken under Section 7 of the ESA by the proposed project are exceeded, (2) the incidental take of migratory bird species protected under the MBTA by the proposed project area exceed the incidental take restrictions in the BO that would result from consultation with USFWS, and (3) BFDs deflect the bald eagle, waterfowl, and special-status bird species sufficiently to meet the USFWS incidental take restrictions under the ESA and MBTA.

Installing Bird Flight Diverters

BFDs and SFDs are 15-inch-long (38-centimeter-long) polyvinyl chloride (PVC) tubing coiled to a height of 7 inches (18 centimeters), and are typically spaced approximately 16 feet (5 meters) apart along the ground wires (Figure E-1). BFDs are especially effective at increasing visibility of wires during fog and rain events and have reduced avian collisions by 57 to 89 percent (Brown and Drewien, 1995). They would be staggered over the two groundwires so that each wire supports one-half of the markers, and are spun onto the groundwire after it is pulled into place and secured on the transmission towers. The BFDs come in gray or yellow with ultraviolet (UV) stabilizers for exposure to sunlight. Conductor wires are normally large enough in diameter to be seen by birds in flight and would not require marking with BFDs.

Monitoring for Bird Collisions

This monitoring plan is based on the studies described by the Avian Power Line Interaction Committee (APLIC) in "Mitigating Bird Collisions With Power Lines: The State of the Art in 1994." The plan includes dead bird searches along the new electric transmission line and around the stacks at the Energy Facility. These searches include studies to develop searcher and scavenger bias estimates that affect the total number of collisions expected to occur. The USFWS and ODFW would be notified if any bald eagles or other special-status birds are found dead from collisions during the dead bird searches.

Conducting Dead Bird Searches

Field searches for dead birds and feather spots (location where feathers are left after removal of carcass by predator or scavenger) would be conducted along the new electric transmission line and in the area around the stacks at the Energy Facility to determine if the project causes significant impacts to birds. Monitoring the new electric transmission line for avian collisions would begin after construction is complete and BFDs are installed. Monitoring of avian collisions with the stacks would occur after construction of the COB Energy Facility is complete.

The searchers would follow a zig-zag pattern through the search areas to allow observations of the entire area. Two to three people would simultaneously conduct the surveys on either side of the new electric transmission line.

If dead birds are found, the following information would be collected:

- Location of each dead bird
- Bird species, sex, age (adult or juvenile), approximate time of death, and physical condition (broken bones, burns, open wounds, gunshot wounds, discoloration, and damage by scavengers)

These data would be recorded on field data sheets in the field (Figure E-2). Necropsies in the lab would be conducted to determine probable cause of death. The USFWS and the ODFW would be notified if any bald eagles of other special-status birds are found dead from collisions.

Analysis of the winter and summer dead bird searches includes evaluation of the field search results, computation of bias estimates and estimated total collisions (see Section 4), and a comparison of observed collision mortality relative to the significance criteria.

Searchers

Qualified biologists familiar with the above-mentioned special-status birds would conduct the dead bird searches. Information would be obtained from Energy Facility personnel if they find dead birds during daily activities, especially around the portion of the new electric transmission line near the Energy Facility. This information would be included in the annual reports. A search bias would be calculated for each searcher (see Search Bias subsection in Section 4) and included in the estimate of total collisions.

Dogs would not be used to conduct searches because there are too many variables in their results (wind, temperature, vegetation height) and a search bias would have to be calculated for each dog, every search day. Search equipment includes binoculars, spotting scope, pin flags, and bird tags.

Search Area

Dead bird searches would be conducted along the entire route of the new electric transmission line. The width of the search area would be determined in relation to the height of the transmission poles (APLIC, 1994). The searches would be conducted in a corridor 164 feet from the outside conductor on either side of the new electric transmission line route (APLIC, 1994). Searches for dead birds around the stacks would be conducted in a 180-foot radius from the stacks, entirely within the security fenceline of the Energy Facility.

Monitoring Schedule

Bald eagles are expected to be in the project area year round (Isaacs, 2002). Surveys for dead bird searches along the new electric transmission line and the stacks would focus on the change of seasons, with two surveys scheduled during the fledging period for the bald eagle. Searches would be conducted once a month in February (winter), May (spring), June or July (summer and probable fledging time), and October (fall).

The dead bird searches would be conducted for the first 3 years after beginning commercial operation of the COB Energy Facility and the new electric transmission line. If monitoring shows insignificant impacts to bald eagles from the project at the end of 3 years, the monitoring frequency would be reduced or monitoring would be discontinued upon approval by USFWS. Annual monitoring reports would be submitted to the USFWS by December 31 of each monitoring year.

4. Data Analysis

Biases can occur in searches for dead and injured birds. Four biases are identified that could cause an underestimation of the number of birds that collide with the new electric transmission line or with the stacks at the Energy Facility: search bias, removal (or predator) bias, habitat bias, and crippling bias (APLIC, 1994). To compensate for the underestimation of avian collisions, these biases would be analyzed and included in the estimated total bird collisions for the project.

Search Bias (SB)

A search bias takes into consideration a searcher's ability and experience, terrain, and vegetation conditions. A bias is measured for each searcher. Dead birds are randomly placed in the search area and the searcher tries to locate as many of the planted birds as possible. A search bias would be calculated for each searcher for each season of the year to adjust for changes in vegetation heights. The proportion of "planted" birds not found determines the search bias. The formula for calculations is as follows:

$$SB = (TDBF/PBF) - TDBF,$$

Where SB = search bias, TDBF = total dead birds and feather spots found in the search area, and PBF = proportion of planted birds found during the recovery.

Example. If eight dead birds are found, including four out of five of the planted birds:
SB = (8/(4/5)) – 8 = 2 birds would not be found by this particular searcher.

Removal Bias (RB)

A removal bias is determined to consider the number of birds scavengers remove from the search area before a search. To measure a removal bias, a number of dead birds are marked and placed in the search area and the condition of the birds are monitored daily for 1 week. Removal bias is the percentage of missing birds with no trace remaining after 1 week. A removal bias would be calculated for each season of the year. The formula to determine removal bias is:

$$RB = (TDBF + SB)/PNR - (TDBF + SB),$$

Where RB = removal bias by scavengers, PNR = proportion of "planted birds not removed by scavengers," TDBF = total dead birds found, and SB = search bias.

Example. If eight dead birds are found and four out of five planted birds are recovered:
RB = (8 + 2)/(4/5) – (8 + 2) = 2.5 birds are expected to be removed by scavengers.

Habitat Bias (HB)

A habitat bias is used only when some portion of a search area is not accessible because of water or dense vegetation. The habitat bias estimates the percent of unsearchable habitat for each transmission line segment. Habitat bias should only be used in limited situations where unsearchable habitat is finely interspersed with searchable habitat and where searchers can demonstrate the number of birds found in searchable and unsearchable habitats are similar. Habitat bias should only be included in the calculation for estimate of total collisions if credible numbers are calculated onsite. The formula to determine habitat bias is:

$$HB = (TDBF + SB + RB)/PS - (TDBF + SB + RB),$$

Where HB = habitat bias, and PS = proportion of area that is searchable

Example. If 95 percent of the search area is searchable:
HB = (8 + 2 + 2)/(95/100) – (8 + 2 + 2) = 0.6 bird may not be found.

Crippling Bias (CB)

A crippling bias is determined to consider the number of birds that fall or move outside the search area. Crippling bias is difficult to obtain (time and effort are involved in monitoring flights and collisions) and estimates from other studies may be inappropriate or misleading. Crippling bias should only be used in the estimate of total collisions if credible numbers are obtained onsite. The formula to determine crippling bias is:

$$CB = (TDBF + SB + RB + HB)/PBK - (TDBF + SB + RB + HB),$$

Where CB = crippling bias and PBK = the proportion of observed collisions falling within the search area.

Example. If four out of five birds that collide with the lines land in the search area, then:
CB = (8 + 2 + 2 + 0.6)/(4/5) – (8 + 2 + 2 + 0.6) = 3.15 birds are expected to collide and go out of the search area.

Estimate of Total Collisions (ETC)

An estimate of total avian collisions can be calculated using the field search results and the above bias estimates. The ETC adds the total dead birds and feather spots found and each of the calculated biases. An ETC would be calculated for each special-status species found during the dead bird searches. The formula to determine ETC is:

$$ETC = TDBF + SB + RB + HB + CB,$$

Where ETC is the estimate of total avian collisions with the segment of electric transmission line studied.

Example: If eight birds are found during the search, then:
ETC = 8 + 2 + 2 + 0.6 + 3.15 = 15.75 birds are estimated to be killed from collisions with the wires in this segment.

Habitat bias and crippling bias should be eliminated if reliable calculations are not available.

An ETC would be determined for each special-status species and averaged over the first 3-year monitoring period. The ETC would be compared to the significance criteria set forth by the USFWS. If the results of the dead bird searches are above the significance criteria after the first 3 years of monitoring, the monitoring program would continue on an annual basis and remedial actions would likely be implemented. If monitoring results show a decrease in the number of special-status birds incidentally taken by the project during the first 3 years, or during the following 3 years, the frequency of monitoring would be reduced or monitoring would be discontinued upon approval by USFWS. If during the dead bird searches large numbers of migratory and/or special-status birds were to be recorded during the dead bird searches, the USFWS and ODFW would be notified immediately.

5. Remedial Actions

If the new electric transmission line or the stacks at the Energy Facility cause significant impacts to bald eagles protected under the ESA, or any special status bird species protected under the MBTA, remedial actions to decrease the incidental take at or below the significance criteria would be implemented.

Remedial actions may include:

- Increase the number of BFDs along the top groundwires.
- Decrease the spacing of BFDs along the top groundwires.
- Add BFDs to the conductor wires.
- Implement a study to determine the cause of excess avian collisions, then develop an appropriate remedial action plan.

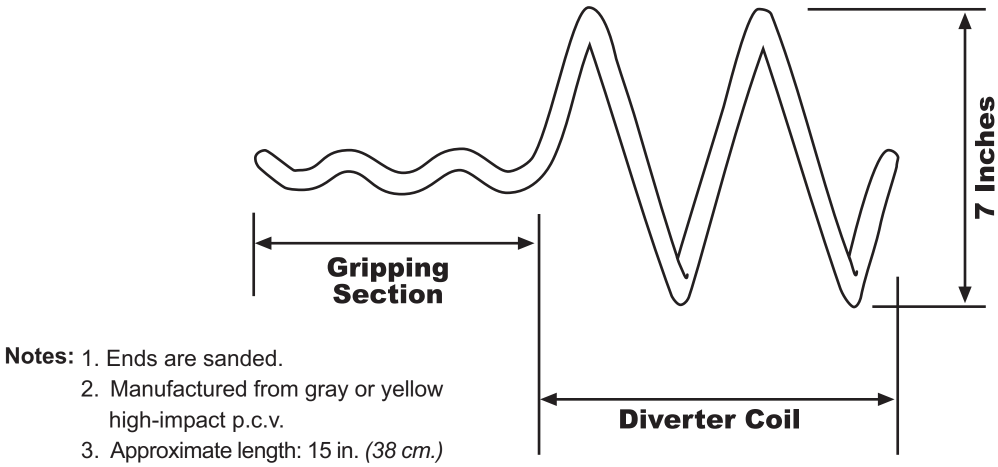
The project proponent would reinitiate consultation with USFWS prior to implementing remedial actions.

6. References

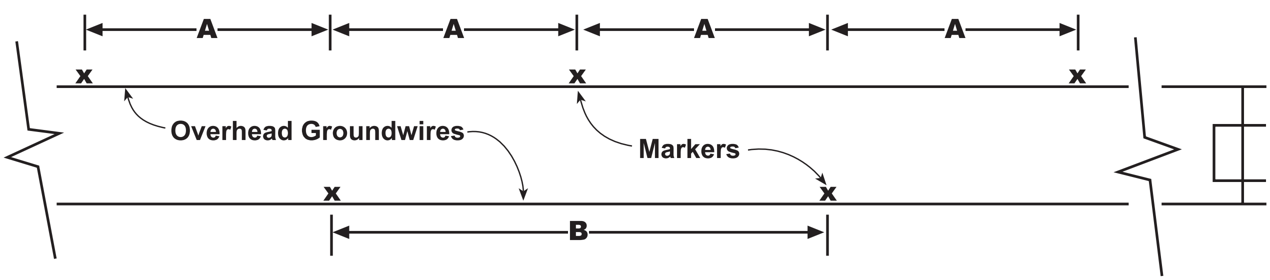
Avian Power Line Interaction Committee (APLIC). 1994. "Mitigating Bird Collisions With Power Lines: The State of the Art in 1994."

Brown, W., and Drewien, R. 1995. "Evaluation of Two Power Line Markers to Reduce Crane and Waterfowl Collision Mortality." Wildlife Society Bulletin, 23(2): 217-227.

Isaacs, Frank B. 2002. Senior Faculty Research Assistant, Oregon State University. Personal communication on August 6, 2002.



Dulmison bird flight diverter (BFD-7)



Spacing	Dimensions	
	A	B
16 feet *(5 meters)*	16 feet	32 feet *(10 meters)*
32 feet *(10 meters)*	32 feet	66 feet *(20 meters)*
49 feet *(15 meters)*	49 feet	98 feet *(30 meters)*

Marker spacing diagram for overhead groundwires

Figure E-1
Example of Bird Flight Diverter and Suggested Spacing on Groundwires
Avian Collision Monitoring Plan
COB Energy Facility
Bonanza, OR

Figure E-2. Avian Collision Data Sheet

Project: Survey objective: Page_____of______

Date: Observer(s): Individual search bias:

T-line segment: Time start:

Equipment: Time end:

Weather conditions: Field conditions:

(wind direction/speed, precipitation, visibility, cloud cover, temperature) (vegetation height, habitat type, flooded)

Time	Location ID on Map	Species	Sex	Age	Approximate Time of Death	Physical Condition	Probable Cause of Death	Remarks

APPENDIX F

Worst-Case Analysis of COB Energy Facility Water Impacts

APPENDIX F TO THE BIOLOGICAL ASSESSMENT

Worst-Case Analysis of COB Energy Facility Water Impacts

The available evidence supports the conclusion that there is no hydraulic connection between the deep and shallow zones, which include the Lost River. However, if one were to assume that an extremely efficient hydraulic connection did in fact exist between the deep system and the Lost River, any impact on the Lost River from the proposed pumping would be imperceptible. To demonstrate this fact, COB Energy Facility, LLC (the project proponent) conducted this "worst-case" analysis. The analysis is not intended to describe an outcome that is likely or even plausible, but rather shows that even if one makes the most conservative assumptions at every step of the process, there still is no potential for a measurable impact on the Lost River.

Summary

The assumptions used in this analysis are sufficiently conservative that they do not actually represent the most probable outcome: no impact at all. This analysis is provided only to create a framework for understanding the magnitude of any potential impact, not to describe a physical mechanism for what might actually occur. The repeatedly conservative assumptions used in this analysis indicate that the maximum reduction in the lowest range of summer flows of the Lost River is roughly 0.00074 gpm as the river passes through the 2-mile reach closest to the Babson well. This reduction would represent a 0.000004 percent reduction in the lowest range of summer flows. This degree of connection is unlikely, and it is additionally unlikely that this impact would result in an impact to fish habitat or passage if it were to occur.

Aquifer Testing and Investigation

Previous borehole geophysics and aquifer testing at the Babson well identified the presence of two separate aquifer systems (see *Groundwater Development Potential and Hydrogeologic Assessment for the Lorella Pumped Storage Project, Klamath County, Oregon* [CH2M HILL, 1994]). The shallow aquifer system (above approximately 500 feet) is a heavily appropriated basalt aquifer that is in varying degrees of hydraulic connection with the Lost River and Bonanza Big Springs. The shallow system is used for irrigation and domestic water supply. The deep aquifer system produces water from water-bearing zones deeper than 1,500 feet below the ground surface (bgs). No data gathered from the monitoring well network during a pump test conducted in August and September 2002 at 6,800 gallons per minute (gpm) for 30 days indicate that the deep aquifer withdrawals would affect groundwater levels in the shallow aquifer, or flows at Bonanza Big Springs and the Lost River. The proposed maximum withdrawal rate of 308 gpm is unlikely to have any measurable effect in the deep zone, much less the shallow zone that lies 1,000 feet higher.

Worst-Case Analysis

The worst-case analysis consisted of the following steps:

1. Predict the worst-case drawdown beneath the Lost River from pumping at the Babson well.
2. Predict the worst-case change in flow of the Lost River resulting from the drawdown.
3. Compare that worst-case change in flow to the average summer flow of the Lost River.

Drawdown Beneath the Lost River

The Babson well investigation shows that the shallow basalt aquifer system at the well extends from approximately 60 to 430 feet bgs. Above the shallow basalt aquifer system lie the typically low-permeability sediments of the Yonna formation. The Babson well lies approximately 0.75 mile west of the Lost River at its closest point. The log for observation well MW-1 shows that the Yonna formation sediments thicken substantially between the Babson well and the Lost River—from 60 feet at the Babson well to 285 feet at MW-1. The progressively deeper bedrock in the center of the valley is expected, and is consistent with the fault-block extension of this basin and range setting.

For this analysis, a conservative assumption was made that the depth of the Yonna formation sediments remains approximately 300 feet throughout the central portion of the valley in the Babson well vicinity, and the shallow basalt aquifer system lies roughly 300 feet below the base of the Lost River (it is likely to be much deeper).

There was a hydraulic response in the observation well network attributable to a leaking well packer during the August and September 2002 pump test (see *Water Supply Supplemental Data Report: Deep Aquifer Testing at the COB Energy Facility Water Supply Well* [CH2M HILL, November 2002]). This slight leak in the seal between the borehole wall and the packer seal resulted in drawdown in the Babson well immediately above the packer. Under worst-case conditions (i.e., the transmissivity of the shallow aquifer system is extremely high), approximately 625 gpm, or 9 percent of the total discharge, would have come from the shallow aquifer system to produce the observed response in the Babson borehole. In order for this analysis to be considered "worst case", a 10 percent contribution will be assumed.

The maximum production rate from the deep aquifer system would be limited to 300 gpm. A 10 percent connection between the shallow and the deep system would result in 30 gpm draining from the shallow basalt aquifer system to the deep aquifer system. Although the average production rate from the well would be substantially less than 300 gpm, this rate was used for the worst-case analysis.

The high shallow basalt aquifer system transmissivity used to speculate about the upper limit degree of possible hydraulic connection was roughly 2.5 million gallons per day per foot (gpd/ft). This value was used to estimate the amount of drawdown in the shallow aquifer system resulting from a 30 gpm withdrawal, 0.75 mile from the Babson well. This distance represents the Lost River's closest point, where drawdown would be at its greatest. The Jacob-Theis equation predicts the first response (defined here as 0.01 foot of head change) would occur approximately 53 hours after the onset of pumping. The drawdown in the shallow aquifer system 300 feet below the Lost River increases to 0.017 foot (0.21 inch), after approximately 1 year of pumping and to 0.021 foot (0.25 inch) after 30 years of pumping.

For the purpose of this worst-case analysis, a maximum theoretical drawdown in the basalt aquifer system 300 feet below the Lost River of 0.03 foot was assumed.

Change in Flow of the Lost River Resulting from Drawdown

The maximum 0.03 foot of drawdown in the shallow basalt aquifer system has to be transmitted vertically upward through the Yonna formation sediments before any potential impact to the Lost River occurs. The vertical hydraulic conductivity of the Yonna formation sediments is unknown. Based on the geologic log CH2M HILL produced for MW-1, the 285 feet of Yonna formation in the Babson well vicinity can be generalized as follows:

- Surface to 35 feet: silt and sand
- 35 feet to 150 feet: clay and diatomite (low-permeability sediments, commonly referred to as “chalk”)
- 150 to 250 feet: volcanic sand and gravel
- 255 to 270 feet: clay and diatomite
- 270 to 285 feet: volcanic sand and gravel

Hydraulic conductivity is a term that describes the ease with which a fluid (water) will move through a material (the aquifer). Effective *horizontal* hydraulic conductivity values are controlled by the high-permeability portions of the aquifer. That is, water tends to move preferentially through the higher-permeability potions of the aquifer. Effective *vertical* hydraulic conductivity is controlled primarily by the low-conductivity portions of the aquifer. That is, the low-permeability portions of the aquifer are the controlling factor limiting the vertical movement of water. To be conservative and predict a worst-case result, the higher-permeability portion of the Yonna formation sediments (volcanic sand and gravel) were ignored (they dampen the vertical movement of a change in head by supplying water horizontally), and the formation was assumed to consist of 130 feet of clay and diatomite.

The horizontal hydraulic conductivity of clay typically ranges from 10E-3 to 10E-5 gallons per day per feet squared (gal/day/ft^2) (Freeze and Cherry, 1979). For this analysis, the maximum value in this range, 0.01 gal/day/ft^2 was used. Vertical hydraulic conductivity is typically a factor of 10 lower than the horizontal hydraulic conductivity. To make this a worst-case analysis, this correction was ignored.

Darcy’s equation was used to estimate the flow through the Yonna formation sediments that would result from this change in head at the base of the sediments:

$$Q = KAi$$

Where:

Q = flux (or flow) in gal/d

K = the hydraulic conductivity (0.01 gal/day/ft2)

A = the area over which the flux is calculated

i = the hydraulic gradient (ft/ft)

The Lost River was assumed to be 50 feet across. The area for the flux calculation was a 1-foot-wide strip of Yonna formation sediments, 50 feet wide, or 50 ft^2. The hydraulic gradient was calculated as the 0.03 foot of maximum head change after 30 years divided by the thickness of the sediments (130 feet), or 0.0002 feet per foot (ft/ft).

Using these values, the volume of water flowing vertically downward through a 1-foot-wide strip of Yonna formation sediments would be 0.0001 gallon per day (gpd), or 0.00000007 gpm.

Change in Flow of the Lost River Compared to Average Summer Flow

The amount of drawdown diminishes with distance from the point of withdrawal. A well pumping 0.1 gpm from the low-permeability Yonna sediments (a rate more than 14,000 times higher than the worst-case predicted flux through 50 ft^2 of Yonna formation) for 30 years would extend a radius of influence of only 6,500 feet. For this analysis, the flux through the Yonna formation was assumed to affect a 2-mile length of the Lost River. To make this worst-case analysis even worse, the flux rate was assumed to remain constant at the peak calculated value along this length, when in fact it would diminish with distance from the well.

The worst-case flow through the 1-foot-by-50-foot strip of Yonna formation sediments was 0.00000007 gpm, and was assumed to be supplied entirely by the Lost River. Along a 2-mile length (10,600 feet), the worst-case change in flow in the Lost River would be 0.00074 gpm.

Summer flows in the Lost River between Keller Bridge and Bonanza typically range from 40 to 80 cubic feet per second (cfs) (Bruce McCoy, Horsefly Irrigation District, Personal Communication, July 2003). This is equivalent to 18,000 to 36,000 gpm. As of August 2003, flows exceed 80,000 cfs. To make this a worst-case analysis, summer flow in the Lost River was assumed to be the lower 18,000 gpm.

If the Lost River flows diminish 0.00074 gpm as the river passes through the 2-mile reach closest to the Babson well, a 0.000004 percent reduction in flow would occur. This reduction could not impact fish habitat or passage.